Pat Ragland
PO Box 2725
Elizabethtown, KY 42702-2725
Email: patragland@outlook.com

Via FOIAonline

National Freedom of Information Officer
U.S. Environmental Protection Agency
Washington, DC

June 30, 2016

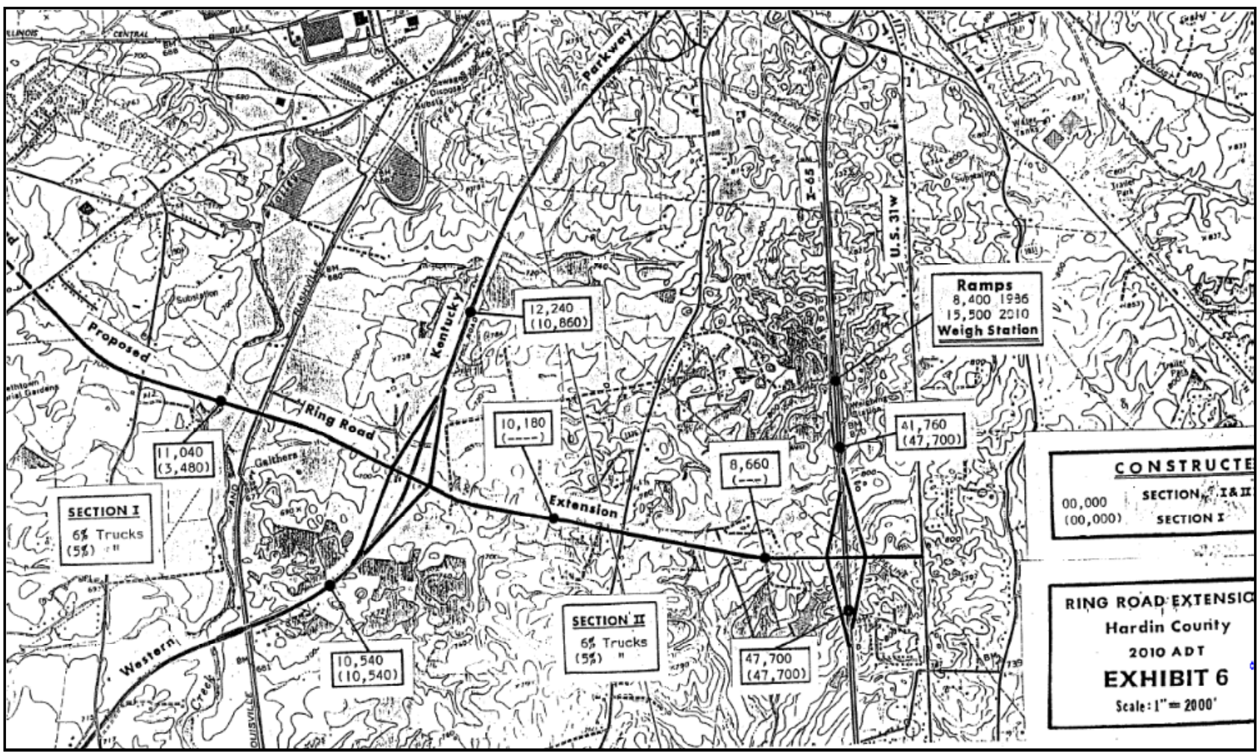
RE: FREEDOM OF INFORMATION ACT REQUEST FOR ALL RECORDS OF KY 3005 (RING ROAD) EXTENSION FROM WESTERN KENTUCKY PARKWAY TO I-65 AND 31-W INCLUDING A NEW INTERCHANGE WITH I-65, ITEM NO. 4-0198.00, HARDIN COUNTY, KENTUCKY.

As the owner of a nearby farm I request all records regarding a new road project proposed to cross highly developed karst and a public Underground Source Of Drinking Water (USDW) in my community. My request is pursuant to the Freedom of Information Act ("FOIA"), 5 U.S.C. Section 552, the implementing regulations of the U.S. Environmental Protection Agency at 40 C.F.R. Part 2, and Obama's "*Presidential Memorandum for the Heads of Executive Departments and Agencies on the Freedom of Information Act*". The new road project is identified as <u>KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00</u>. The decision makers and the public must have full disclosure of environmental risks to evaluate the actual risks. Alternative locations can easily avoid both the highly developed karst and the public Underground Source Of Drinking Water (USDW). I request all records the U.S. Environmental Protection Agency possesses regarding <u>KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00</u>.

1. INTERCHANGES ARE FEDERAL INVOLVEMENT

The 1987 study *Ring Road Extension Hardin County* (Appendix 1) describes this KY 3005 (Ring Road) Extension from an interchange with the Western Kentucky Parkway (WKP) to an interchange with Interstate 65 (I-65) and an interchange with US 31 W as "Section 2" in part "IV B" and on "Exhibit 6" as follows:

> *Section 2*
> *This section begins at the proposed Ring Road - WKP Interchange and continues southeast crossing Glendale Road approximately 2.3 miles from its interchange with the US 31W Bypass. The proposed 2.08-mile alignment ties into 1-65 with a diamond interchange to allow for an eventual at-grade intersection with US 31W. The location of the proposed interchange with I-65 permits future extensions to occur with minimal damage.*



The requirement for a Federal Highway Administration Interchange Justification Study for this road project is stated in Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2) on page 3 under "Section I Roadway Deficiencies" and on page 6 under "Section V Summary". The Federal Highway Administration's *Interstate System Access Information Guide*[1] on page 7 states as follows:

> *The final approval can be granted only after the National Environmental Policy Act (NEPA) process is completed. The NEPA process must be followed regardless of the source of funding (including private funding) for the project, since approval of the proposed change in access* ***constitutes a Federal Action****. The development of final plans, specifications and engineering, and right-of-way acquisition and construction may be performed only after this final approval is granted.*

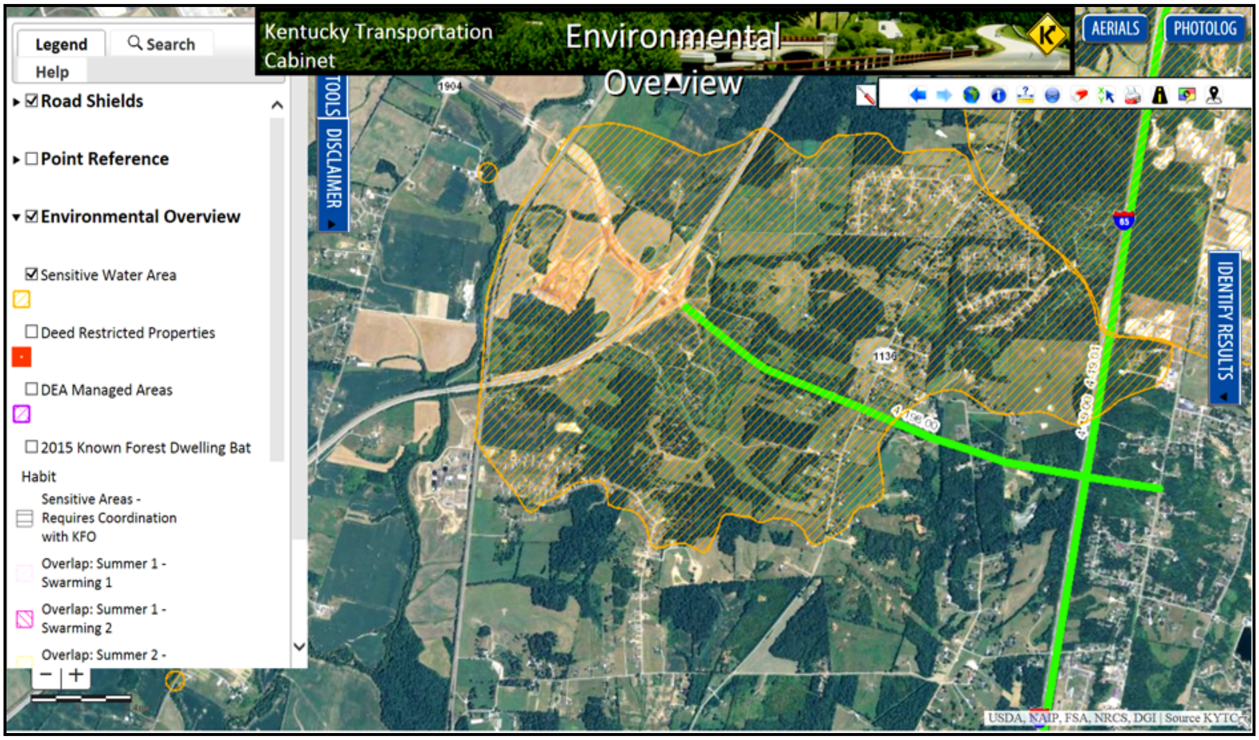
My FOIA request for all records specifically includes all records regarding interchange justifications for the KY 3005 (Ring Road) Extension interchanges with U.S. 31W, with Interstate 65 (I-65), with KY 1136 (also known as the New Glendale Road), and with the Western Kentucky Parkway (also known as the Wendell H. Ford Parkway).

2. THE CURRENT ROAD PROJECT ALTERNATIVE WOULD INTRODUCE CONTAMINANT SOURCES INTO THE "*GAITHER SPRING*" (ALSO KNOWN AS "*DYERS SPRING*") WELLHEAD PROTECTION AREA.

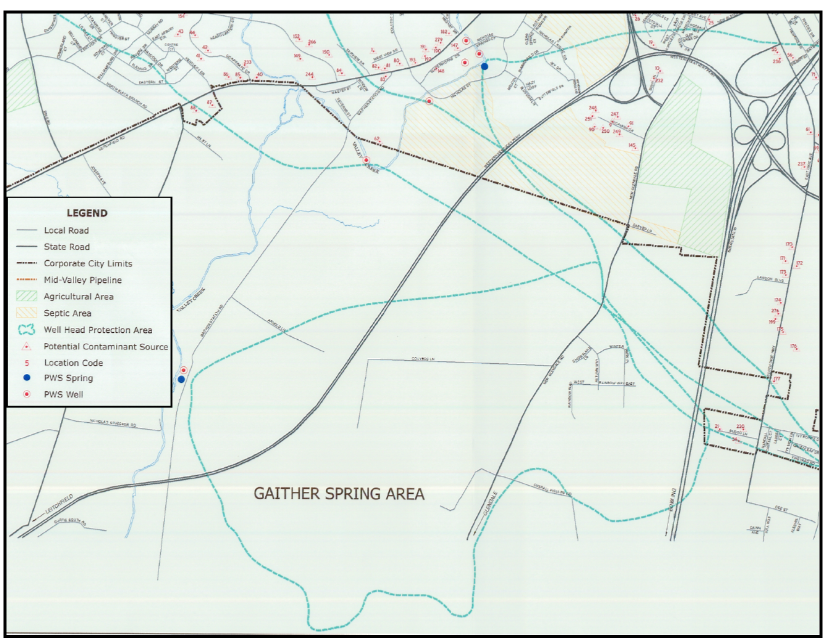
The current alternative for KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00 intrudes through the "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area. This road intrusion of the "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area is shown as the east-west green line "*4-198.00*" project going through the diagonally lined "*Sensitive Water Area*" on Kentucky Transportation Cabinet's Environmental Overview web map[2] as follows:

[1] The Federal Highway Administration's August 2010 *Interstate System Access Information Guide* is available at https://www.fhwa.dot.gov/design/interstate/pubs/access/access.pdf

[2] Kentucky Transportation Cabinet's Environmental Overview web map is available at http://maps.kytc.ky.gov/photolog/?config=EnvironmentalOverview



Fortunately, this sensitive "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area has remained free of industrial and commercial potential contaminant sources as shown by an excerpt of the *City of Elizabethtown, Potential Contaminant Sources* map[3] as follows:



[3] The *City of Elizabethtown, Potential Contaminant Sources* map is part of the Elizabethtown Water Department's 2009 five year update of their Wellhead Protection Plan on file with the Kentucky Division of Water.

The U.S. Geological Survey and the Kentucky Division of Water delineated the recharge area and determined the sensitive karst characteristics of the "*Gaither Spring*" (also known as "*Dyers Spring*") recharge area as reported in 1997 in *Delineation Of Ground-Water Basins And Recharge Areas For Municipal Water-Supply Springs In A Karst Aquifer System In The Elizabethtown Area, Northern Kentucky* [4] (Appendix 3) as follows:

> *Two springs in southeast Hardin County, Kentucky, Elizabethtown Spring (also known locally as City Spring) and Dyers Spring (Gaithers Station Spring), are used as the primary sources of municipal water for the City of Elizabethtown (fig. 1). About 1.4 Mgal/d is withdrawn from Elizabethtown Spring and about 567 Kgal/d is withdrawn from Dyers Spring during periods of highest consumptive use (Robert Best, Manager, Elizabethtown Water Plant, oral commun., 1995).*
>
> *Conduit-dominated karst aquifers are widely recognized as being much more sensitive to groundwater contamination or degradation resulting from certain land-use practices than are typical granular and fractured-rock aquifers (Field, 1990). ...*
>
> *Because of the concern for the increased potential for contamination and degradation of these two water-supply springs, the U. S. Geological Survey, in cooperation with the Kentucky Division of Water, Department of Environmental Protection, Natural Resources and Environmental Protection Cabinet, conducted an investigation to delineate the recharge areas of Elizabethtown and Dyers Springs and to gain a better understanding of the distribution and boundaries of the ground-water basins in the karst aquifer system in the Elizabethtown area. This report presents the results of that investigation, which used a hydrogeologic-mapping approach that included potentiometric map interpretation and dye-tracing tests.*
>
> *The information presented in this report is intended to aid water-supply managers and State regulators in developing a water-supply management and protection plan for Elizabethtown and Dyers Springs and to illustrate the use of hydrogeologic mapping methods to investigate the characteristics of karst aquifer systems.*

The karst aquifer characteristics of the "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area make this Underground Source Of Drinking Water (USDW) very sensitive to contamination. Time of travel for a contaminant release to reach the public water

---

[4] Quote is from pages 1 and 3 of Taylor, Charles J. *Delineation Of Ground-Water Basins And Recharge Areas For Municipal Water-Supply Springs In A Karst Aquifer System In The Elizabethtown Area, Northern Kentucky*. U.S. Geological Survey Water-Resources Investigations Report 96-4254. Available at http://pubs.usgs.gov/wri/1996/4254/report.pdf [Accessed 2/10/2015.]

intake at "*Gaither Spring*" (also known as "*Dyers Spring*") is measured in hours as determined by the U.S. Geological Survey[5] (Appendix 4) as follows:

> *The apparent traveltime for the leading edge of the dye cloud between the karst window, site 15 and Dyers Spring (site 16) were 5 and 24 hours for traces 18 and 23, respectively, based on the straight line distance of 3,000 feet.*

However, Kentucky's 1993 *Wellhead Protection Program* (Appendix 5) specifies incompatible potential contaminant sources are to be located outside of sensitive wellhead protection areas as follows:

> Page 19: *Specific management strategies are discussed in the Management Approaches section. Remedial action zones are established* ***to protect the well or spring from unexpected contaminant releases and to minimize that likelihood by locating certain high-risk activities outside of the more sensitive WHPAs***.
>
> Page 34: *WHPA-3 is the boundary marking the outer limits of the recharge area. This boundary is not required in certain circumstances due to specific aquifer characteristics. Management controls in WHPA-3 should* ***direct the siting of incompatible potential sources of groundwater contamination outside of the recharge area*** *and implement best management practices for existing sources. Pollution prevention strategies and public education will be the most effective management tool for protecting WHPA-3.*
>
> Pages 35-36: *All of the information associated with WHP such as locations of water sources, contaminant sources and dimensions of WHPA boundaries will be stored with other groundwater data in the states geographic information system (GIS) and in parameter specific databases. The GIS system is capable of plotting several different types of information in a scaled map format. The Groundwater Branch maintains databases that track groundwater quality, sources, and tracing results. This information is also plotted on 1:24,000 scale topographic maps for quick reference.* ***This information will be used to direct the future siting of potential contaminant sources away from PWSs****. All of this information is available to the public.*

Therefore KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00.is not to introduce potential

[5] Quote is from page 59 in: Mull, Donald S., James L. Smoot, and Timothy D. Liebermann. *Dye tracing techniques used to determine ground-water flow in a carbonate aquifer system near Elizabethtown, Kentucky*. No. 87-4174. US Geological Survey,, 1988.

contaminate sources into the sensitive "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area.

The Federal Highway Administration recognizes[6] the need for site specific understanding of highway runoff particularly for karst areas as shown by select quotes from *Is Highway Runoff a Serious Problem?* (Appendix 6) as follows:

> *Know the quality of the runoff and then design the treatment to fit the problem.*
>
> *However, contaminants can also reach ground waters rather quickly through drainage entering fractured rock formations or sinkholes in Karst areas.[8] (Karst usually occurs in limestone areas and is characterized by caves, openings, and sinkholes.) Ground water is more sensitive to contamination in these areas because runoff may pass directly into the subsurface with little if any infiltration through the soil. Contamination of ground waters is less visible than that of surface waters, and, given that sampling and clean up is quite difficult and expensive, prevention of contamination is the most effective way of protecting them.*
>
> *Deicing chemicals are often combined with other substances to prevent caking or inhibit corrosion. These substances may be toxic to human, animal, and fish life. Sodium ferrocyanide, for instance, is often used to prevent caking, but, unfortunately, releases cyanide ions that are extremely toxic to fish. Rust inhibitors, on the other hand, may contain phosphorus compounds that, in turn, stimulate the growth of undesirable aquatic plants, weeds and algae in fresh-water lakes.*
>
> *Highway runoff may contain higher concentrations of metals, particularly: lead, zinc, iron, chromium, cadmium, nickel, and copper, that result from the ordinary wear of brakes, tires, and other vehicle parts.*
>
> *Heavy metals in highway runoff generally undergo physical, chemical, and biological transformations as they reach adjacent ecosystems. Sometimes, they are taken up by plants or animals, or adsorbed on clay particles. Other times. they settle to bottom sediments, or re-dissolve back into solution. Particulate fractions settling to the bottom surface of receiving waters may develop into sediments after several years of continuous deposition. These sediments may or may not leach metals depending on the condition and sensitivity of the receiving water. For example, chloride and acetate (from deicing chemicals) trigger the movement of metals that would otherwise remain in soil-ion exchange sites usually found in the first 20cm of the soil columns in sediments.*

---

[6] United States Department of Transportation, Federal Highway Administration (2012), *Is Highway Runoff a Serious Problem?*, FHWA Environmental Technology Brief, Publication Number: FHWA-RD-98-079.

Various studies have revealed that low pH levels may also trigger metal solubility and leaching, especially when pH levels drop below 7.

Similarly, small concentrations of ionic zinc and cadmium are more readily available and toxic to aquatic life than large concentrations of their organic or non-ionic forms. Heavy metals in highway runoff are usually not a toxicity problem, but an analysis of each situation is prudent so that treatment is provided where appropriate.

With the current alternative, runoff would adversely impact the sensitive "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area.

The U.S. Geological Survey has provided expert analysis of Florida karst aquifers[7] (Appendix 7) that has been used to provide groundwater protection measures as follows:

Consequently, there is great interest in understanding the physical and biogeochemical processes affecting groundwater quality in carbonate aquifers, particularly in carbonate formations that have undergone karstification. Karst aquifers are typically viewed as excellent municipal sources of groundwater because they contain highly permeable solution-enlarged pore space from which to extract water. Problems of contamination and waterborne pathogens associated with domestic water supplies withdrawn from karst aquifers have been well documented [Aley, 1984], some of which have resulted in disease epidemics [Pokrajčić, 1976; Worthington et al., 2002]. ***Source water protection in karst aquifers, however, is difficult to achieve because of the potential for rapid movement of solutes in solution-enlarged zones and limited attenuation of pollutants.***

It became necessary for the U.S. District Court to use the U.S. Geological Survey's karst hydrology expertise to set aside U.S. Army Corps of Engineers permits that disregarded adverse impacts to the source water and failed to analyze practicable alternatives[8] as follows:

As discussed above, I have determined that the Corps acted arbitrarily and capriciously in concluding that this limestone excavation is water dependent and that no practicable alternatives existed. The Corps failed to articulate any explanation for its determination that the basic purpose of this project was water dependent, and failed to document any "analysis" of the practicable alternatives to this proposed mining, in violation of both the CWA and NEPA. Moreover, by

[7] Renken, Robert A., et al. *Pathogen and chemical transport in the karst limestone of the Biscayne aquifer: 1. Revised conceptualization of groundwater flow.* Water Resources Research 44.8 (2008), page 1.

[8] Quoting Opinion Conclusion and footnote 33 in *Sierra Club v. Van Antwerp*, 709 F. Supp. 2d 1254 - Dist. Court, SD Florida 2009.

failing to hold these limestone corporations to the test of "clearly demonstrating" the absence of practicable alternatives, the Corps failed to comply with 40 C.F.R. 230.10(a)(3). The EIS also failed to meet NEPA's requirements because the Corps adopted challenged data and conclusions submitted by the permit applicants without independent evaluation, and omitted pertinent information related to the anticipated cost of upgrades to the water treatment plants. Based on the record before the Court, the Corps was arbitrary and capricious in determining that the ten year permits would have no significant effect other than identified in the EIS, in part because the EIS itself was insufficient to meet NEPA's demands.

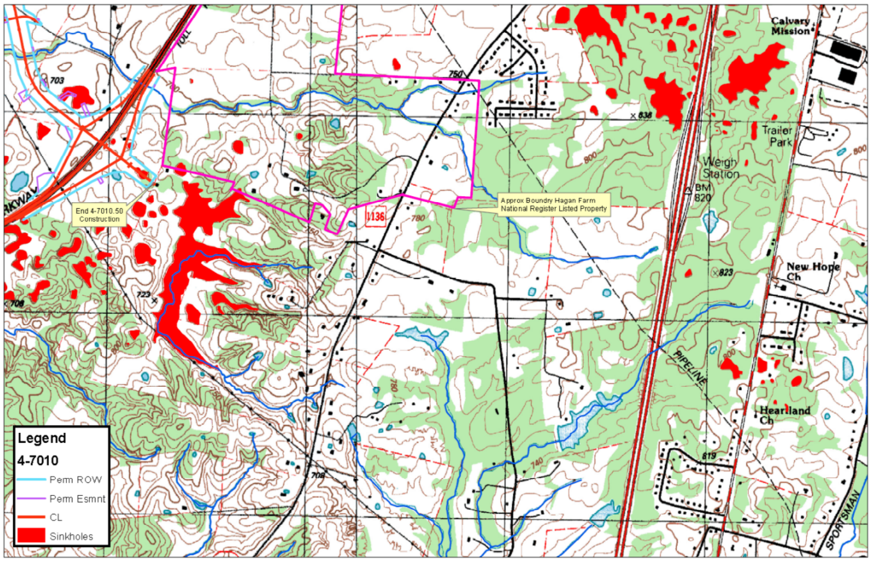
The Corps failed to comply with statutory and regulatory directives and was arbitrary and capricious in its decision to issue the permits. The Corps' decision to issue these permits in 2002 must be set aside.

[33] The Court notes that after the permits were issued by the Corps, the County hired the United States Geological Survey (USGS) to perform several field studies. Notably, the studies in 2003 revealed a much faster transmissivity in the Aquifer than expected. Despite the almost universal understanding that the Wellfield protections on which these challenged permits are based are inadequate, see e.g., the USGS study (Plaintiffs' Exh. 9, p. 319, Plaintiffs' Exh. 23, and County reports: Tr. 431) (Dr. Markley), Tr. 4248-49, 4276 (Dr. Yoder), Tr. 1438-40 (Brant), the Corps ignored specific evidence presented by Plaintiffs in early 2004 that the Wellfield protections are "no longer accurate." SAR1317 (Letter from NRDC to Corps, dated February 16, 2004). The Corps admitted that it never discussed the 2003 USGS study with the USGS. Tr. 2751 (Studt), despite the "Three Year Review" reporting and the water quality monitoring conditions relied upon in the 404(b)(1) analysis reported in the ROD.

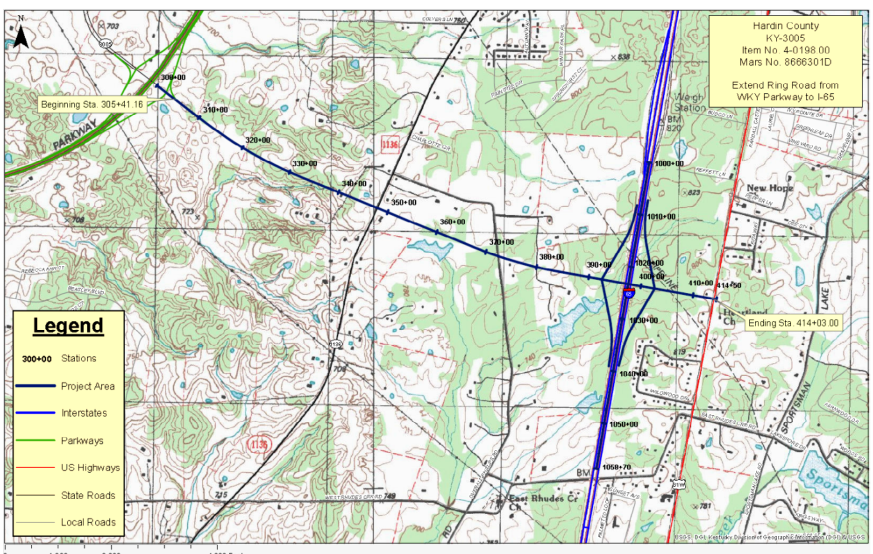
My FOIA request for all records specifically includes all records regarding environmental impacts to the "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area from KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00.

3. THE CURRENT ROAD PROJECT ALTERNATIVE INTRUDES THROUGH HIGHLY DEVELOPED KARST.

The current alternative for KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00 intrudes through highly developed karst. This highly developed karst is shown as a cluster of sinkholes shaded in red around the intersection of KY 3005 (Ring Road) with Western Kentucky Parkway in the upper left quadrant of the Kentucky Transportation Cabinet's *4-0198_Environmental Map*[9] as follows:



This alternative intruding through this cluster of sinkholes is evident by comparing the above *4-0198_Environmental Map* with Item No. 4-0198.00 plan map[10] (Appendix 8) below as follows:



[9] Kentucky Transportation Cabinet's *4-0198_Environmental_Map.pdf* for planning the extension of Ring Road to I-65 is available at http://transportation.ky.gov/Planning/Planning%20Studies%20and%20Reports/4-0198_Environmental_Map.pdf [Accessed May 7, 2016.]

[10] Item No. 4-0198.00 plan map is just after page 10 of the January 26, 2016 (R-066-2014) geotechnical report for *Ring Rd. Extension: Western KY Pkwy to I-65, Item No. 4-198.00* which is available at: http://kgs.uky.edu/kgsweb/KYTC/Reports/R-066-2014.pdf

Inadvisably the current road alternative would alter the natural karst drainage by discharging roadway drainage into several sinkholes and by capping other sinkholes. These proposed alterations to the natural karst drainage are stated in the January 26, 2016 geotechnical report for *Ring Rd. Extension: Western KY Pkwy to I-65, Item No. 4-198.00* [11] (Appendix 8) as follows:

> *Several sinkholes/basins have been identified on this project. Three sinkholes/basins will be receiving roadway drainage. Treatment for these sinkholes is outlined in Geotechnical Recommendations No. 16 and 17. The appropriate design procedures for sinkholes receiving drainage are to be detailed in the plans in accordance with the recommendations given below. Sinkholes within disturbed limits that are not receiving roadway drainage shall be filled/capped in accordance with Section 215 of the Standard Specifications, and the Sepia Drawing "Treatment of Open Sinkholes". These sinkholes are identified in Geotechnical Recommendation No. 15 below.*

However, discharging roadway drainage into sinkholes would increase the velocity of ground-water movement and increase the magnitude of water-level fluctuations in the karst drainage. Both of these actions enlarge cavities in the unconsolidated deposits by "erosion from below" to result in surface collapses. Furthermore, capping sinkholes would obstruct natural karst drainage and cause rainfall runoff to find new pathways into groundwater by washing unconsolidated deposits out of presently choked fissures, by seepage from detention basins, by flowing to other sinkholes, etc. The U.S. Environmental Protection Agency describes adverse impacts resulting from filling karst voids[12] (Appendix 9) as follows:

> *Void filling will isolate the underground opening on either side of the fill. Animal migration, water flow, and air flow would be drastically impacted. The damming effect could redirect the water into other ecosystems that are currently dry or cause a blow out on the ground surface or beneath an embankment section.*

---

[11] Quoting from page 3 of the January 26, 2016 (R-066-2014) geotechnical report for *Ring Rd. Extension: Western KY Pkwy to I-65, Item No. 4-198.00* which is available at: http://kgs.uky.edu/kgsweb/KYTC/Reports/R-066-2014.pdf

[12] Page 25 Section 6.4 in *EPA Comments Concerning the I-69 Evansville to Indianapolis, Tier 2 Draft Environmental Impact Statement, Section 4 – Crane NSWC to Bloomington, Indiana*, CEQ No. 20100281. Available at *http://www.hecweb.org/wp-content/uploads/2010/12/EPA-comments-on-Sec-4-DEIS-10-28-10.pdf*

Therefore according to the U.S. Geological Survey in *Development of Sinkholes Resulting From Man's Activities in the Eastern United States*[13] (Appendix 10) discharging roadway drainage into sinkholes and capping sinkholes would predictably accelerate man induced sinkholes as follows:

> *Mechanisms that trigger induced sinkhole development resulting from a decline in water level are (1) a loss of buoyant support,(2) increase in velocity of ground-water movement, (3) increase in magnitude of water-level fluctuations, and (4) the movement of water from the land surface to openings in bedrock where recharge had previously been largely rejected.*
>
> *Where and when natural sinkholes will occur is not predictable. Induced sinkholes resulting from water activities <u>are predictable</u> in some instances, but only in the sense that <u>they will occur within a particular area</u>.*

Identifying the need to avoid the highly developed karst should have occurred much earlier in the road project design process. Application of Context Sensitive Design avoids adverse environmental consequences before engineers determine an alignment. Context Sensitive Design has been supported by the Federal Highway Administration for planning road projects[14] (Appendix 11) since at least 2002 as follows:

> *This is an advance over outdated agency processes in which engineers determine an alignment or plan, and then "after-the-fact" evaluate the plan for adverse environmental consequences. ...*
>
> *Failure can be expected when the level of engineering greatly exceeds the level of environmental analysis or vice versa. For example, not having enough information about the affected environment while advancing a design concept can lead to the discovery of a deal-breaker late in the process and the need to go back and search for another alternative.*

According to the U.S. Environmental Protection Agency[15] (Appendix 9) environmental analysis must consider karst resources when karst features are present in a design alternative as follows:

---

[13] Quotes are from pages 39 and 40 of U.S. Geological Survey "Circular 968" by Newton, John G. *Development of sinkholes resulting from man's activities in the eastern United States*. No. 968. USGPO,, 1987.

[14] Quoting from pages 35 and 41 of Carlson, E. Dean, et al. *National Cooperative Highway Research Program*, Report 480, 2002.

[15] Quoting from pages 14 and 15 in *EPA Comments Concerning the I-69 Evansville to Indianapolis, Tier 2 Draft Environmental Impact Statement, Section 4 – Crane NSWC to Bloomington, Indiana*, CEQ No. 20100281. Available at *http://www.hecweb.org/wp-content/uploads/2010/12/EPA-comments-on-Sec-4-DEIS-10-28-10.pdf*

> *With respect to karst resources, in order to adequately assess alternative impacts, consideration must be given to karst feature size, location, infiltration rate, recharge/discharge characteristics, connectivity to groundwater conveyances, potential T&E species impacts, potential water quality impacts, threats to the traveling public, etc.*

Adverse impacts from alterations of the natural karst drainage can be avoided by alternative locations that avoid the highly developed karst. A catastrophic karst collapse occurred beneath Dishman Lane in Bowling Green, Kentucky on February 25, 2002 as shown by a photograph (Appendix 12) on the Kentucky Geological Survey's chart "*Geologic Hazards in Kentucky*"[16]. The failure of Bowling Green's planning to design Dishman Lane to avoid the area with the known highest potential for karst collapse is described in *Sinkholes and Subsidence: Karst and Cavernous Rocks in Engineering and Construction*[17] as "Case Study # 2, Collapse sinkhole at Dishman Lane, Kentucky" on pages 277 to 282 (Appendix 13). This "Case Study # 2" concludes with:

> *Loss of the road was due to inadequate design procedures, where professional hydrogeological expertise was sought* ***but then not applied****. Designing the road on the basis of incorrect maps, when an earlier correct map had been lost or forgotten. was a* ***catastrophic error in management*** *of the ground investigation. It appears that the Dishman Lane collapse was* ***totally avoidable****.*

Altering the natural karst drainage creates karst flooding in addition to karst collapses. Failures to identify the environmental consequences of infrastructure projects and community developments result in adverse impacts that must attempt to be addressed after the fact. One current Hardin County, Kentucky example is the proposed remediation of Quiggins Sinkhole watershed flooding[18] (Appendix 14) as follows:

---

[16] *Geologic Hazards in Kentucky,* publication number 17235, MCS_185_12 is available at: http://kgs.uky.edu/kgsweb/olops/pub/kgs/mc185_12.pdf

[17] *Sinkholes and Subsidence: Karst and Cavernous Rocks in Engineering and Construction* published by Springer as ISBN 3642058515.

[18] Quoting pages 1 and 2 of FEMA's *Environmental Assessment Quiggins Sinkhole Flood Mitigation Project, City of Radcliff, Hardin County, Kentucky*, DR-KY-1818-0012, February 12, 2015, available at: *http://www.fema.gov/media-*

> *The need for this project is to eliminate damages to structures located around the project area and protect the use of two major thoroughfares in the City of Radcliff (City) – South Wilson Road and U.S. Route 31-W. These two roads carry a combined total of approximately 33,790 vehicles per day through the City. The City is adjacent to the U.S. Army's Fort Knox Military Base and most of the incoming and outgoing traffic from the base travels through the City on U.S Route 31-W and South Wilson Road. U.S. Route 31-W is also the major thoroughfare for Hardin County (see Appendix A, Figure 1 for overview map). Repetitive flooding from heavy rains (up to the 1.0 inch storm event) overtops South Wilson Road, causing closure of the road, trapping residents in homes, and causing the re-routing of 4,590 vehicles per day. Flooding from a very large rain event (i.e. 1 % chance storm event) will overtop U.S Route 31-W, causing the re-routing of approximately 29,200 vehicles per day. and flooding many structures in the area. In 1997, 54 homes and commercial businesses in the area were flooded from a 1% chance flood event.*
>
> *Under the No Action Alternative both residential and commercial/industrial properties would continue to be flooded, resulting in flood-related property damages. In addition, South Wilson Road and U.S. Route 31-W would continue to be severely impaired during flood events in this portion of the City of Radcliff.*

Even with the proposed remediation, karst flooding is expected to close South Wilson Road ten days per year[19] (Appendix 14) as follows:

> *Excavation of Quiggins Sinkhole would lower the 100-year flood elevation by 1.1' and reduce the number of days of South Wilson Road closure from approximately 21 to 17 per year. Excavation of Quiggins Sinkhole plus the construction of four basins would lower the 100 year flood elevation by 4' and reduce the number of days of South Wilson Road closure from approximately 21 days to 10 days per year.*

My FOIA request for all records specifically includes all records regarding impacts to the karst environment for <u>KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00</u>.

---

library-data/1432033650131-686006c95b5714bd20685e8a81ccfee3/201504200-Quiggins_Basin_508-FINAL-EA.pdf

[19] Quoting page 29 of QK4, 2009. *Quiggins Hydrologic Study.* QK4, Louisville, Kentucky. This study is a reference report in Appendix C of FEMA's *Environmental Assessment Quiggins Sinkhole Flood Mitigation Project, City of Radcliff, Hardin County, Kentucky*, DR-KY-1818-0012, February 12, 2015, available at: *http://www.fema.gov/media-library-data/1432033650131-686006c95b5714bd20685e8a81ccfee3/201504200-Quiggins_Basin_508-FINAL-EA.pdf*

4. DECISION MAKERS MUST EVALUATE THE RISKS OF THE BIOLOGICAL IMPACTS.

Decision makers for KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00 must evaluate the risks of biological impacts.

My FOIA request for all records specifically includes all records regarding impacts to the biological environment for KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00 including but not limited to organisms that live in underground waters such as cave crayfish and the vulnerable Kentucky cave shrimp, *Palaemonias ganteri*.

5. ALTERNATIVES MUST BE DEVELOPED TO AVOID ADVERSE ENVIRONMENTAL IMPACTS.

The Federal Highway Administration recognizes the importance to avoid adverse environmental impacts by developing alternatives[20] to avoid impacts (Appendix 11) as follows:

> *A key concept in both CSD/CSS and NEPA is the notion that consideration of approaches for reducing adverse environmental impacts is required in the course of developing alternatives. The first aim is to avoid impacts entirely. Avoidance not only is best environmentally, but is generally the least expensive option. ...*
>
> *Considering effects on environmental resources as an integral part of alternatives development, rather than an after thought following selection of the preferred alternative, will address many resource agency and public criticisms of transportation decision making processes.*

The Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2) shows Federal Actions by the Federal Highway Administration approval for changes to interstate access and by the need for U.S. Army Corps of Engineers permitting. The requirement for a Federal Highway Administration Interchange Justification

[20] Quoting from pages 40 and 42 of Carlson, E. Dean, et al. *National Cooperative Highway Research Program*, Report 480, 2002.

Study for this road project is stated in Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2) on page 3 under "Section I Roadway Deficiencies" and on page 6 under "Section V Summary" as follows:

> *Consultants shall be required to develop an Interstate Justification Study . The IJS fulfills the requirement by the FHWA that seeks an evaluation of impacts for all new requests for interstate access.*

The Federal Highway Administration's *Interstate System Access Information Guide*[21] on page 7 states as follows:

> *The final approval can be granted only after the National Environmental Policy Act (NEPA) process is completed. The NEPA process must be followed regardless of the source of funding (including private funding) for the project, since approval of the proposed change in access **constitutes a Federal Action**. The development of final plans, specifications and engineering, and right-of-way acquisition and construction may be performed only after this final approval is granted.*

The Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2) on page 4 under "Section E Permitting" shows a Clean Water Act Section 404 Permit will likely be required. Such a 404 Permit approval is a major federal action by 40 CFR §1508.18 (b) (4) as follows:

> *40 CFR §1508.18 Major federal action*
>
> *(b) Federal actions tend to fall within one of the following categories:*
>
> *(4) Approval of specific projects, such as construction or management activities located in a defined geographic area. Projects include actions approved by permit or other regulatory decision as well as federal and federally assisted activities.*

The Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2) on page 1 under "Preliminary Project Information" shows the proposed KY 3005 (Ring Road) Extension Item No. 4-0198.00 is to be a new four lane

[21] The Federal Highway Administration's August 2010 *Interstate System Access Information Guide* is available at https://www.fhwa.dot.gov/design/interstate/pubs/access/access.pdf

controlled access highway project.[22] Therefore this road project will be a "Class I" action that requires a National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS) as 23 CFR § 771.115 (a) states:

> 23 CFR § 771.115 Classes of actions.
> There are three classes of actions which prescribe the level of documentation required in the NEPA process.
> (a) *Class I (EISs).* Actions that significantly affect the environment require an EIS (40 CFR 1508.27). The following are examples of actions that normally required an EIS:
>
> (1) A new controlled access freeway.
> (2) A highway project of four or more lanes on a new location. ...

The Federal Actions in <u>KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00</u> require project planning to include the National Environmental Policy Act development of alternatives in addition to the Context Sensitive Design development of alternatives to avoid adverse environmental impacts. Nevertheless the current alternative does not avoid adverse environmental impacts.

Furthermore the Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2) on page 2 states this proposed new road project will provide access between I-65, Western Kentucky Parkway, and the existing Elizabethtown Industrial Park along US 62 [23] as follows:

> *This section of Ring Road (KY 3005) will continue the previous segment and provide a direct southen access point to I-65 therefore connecting the WK Parkway, the Industrial Park area along the south end of Ring Road and the western portion of US 62.*

Therefore hazardous industrial chemicals would be transported along this proposed new road project.

---

[22] On page 1 of the Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2).

[23] Quote is from page 2 of Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2) section "C. System Linkage". Available at: http://transportation.ky.gov/Planning/Pages/Project-Details.aspx?Project=KY 3005 Extension DNA Scoping Study – Hardin County – 4-198.00

Many industrial chemicals pass through earthen lined detention structures and contaminate public Underground Source of Drinking Water (USDW) in karst aquifers. Kentucky's karst Best Management Plan (BMP) *Design Memorandum No. 12-05* [24] (Appendix 15) for road construction is designed to trap suspended solids by detention. However, this earthen lined detention structure is not capable of controlling soluble chemical contaminants of runoff or spills. Soluble contaminates such as methyl tert-butyl ether (MTBE) will persist into the public Underground Source of Drinking Water (USDW) as reported by the U.S. Geological Survey[25] (Appendix 16) as follows:

> *MTBE is quite volatile and would be expected to dissipate rapidly from soil or water surfaces (U.S. Environmental Protection Agency, 1993a). However, MTBE is about 40 times more soluble than the BTEX compounds and is less biodegradable than many common gasoline hydrocarbons. As a result, it is expected to be comparatively more persistent in ground water and in the shallow, fast-moving streams that are typical of urban and highway-runoff conveyances (Delzer and others, 1996). MTBE has been found in ground-water supplies at levels in excess of 200 milligrams per liter (mg/L) in some locations (U.S. Environmental Protection Agency, 1993b), posing a potential exposure risk to humans and aquatic life.*

For comparison the Kentucky Department for Environmental Protection uses 0.050 mg/L as the water quality standard risk-based number for methyl *tert*-butyl ether (MTBE)[26] (Appendix 17).

Transporting hazardous industrial chemicals along the current alternative would unnecessarily risk a spill to make the karst aquifer of the "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area unusable as a public water supply. For example a spill of an

[24] The karst BMP *Design Memorandum No. 12-05* is available at http://transportation.ky.gov/Highway-Design/Memos/Design%2012-05.pdf [accessed 2016/02/28]

[25] Buckler, D. R., and G. E. Granato. 1999. *Assessing biological effects from highway-runoff constituents*. U. S. Geological Survey "Open-File Report 99-240", page 5.

[26] The Kentucky Department for Environmental Protection's risk-based number for methyl *tert*-butyl ether (MTBE) is in Fisher, R. Stephen, Bart Davidson, and Peter T. Goodmann. *Groundwater Quality in Watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek* (Kentucky Basin Management Unit 5). Kentucky Geological Survey, University of Kentucky, 2008, page 11. Available at http://kgs.uky.edu/kgsweb/olops/pub/kgs/water/RI19_12/RI19intro.pdf

industrial dense non-aqueous phase liquid (DNAPL) would contaminate the public Underground Source of Drinking Water (USDW) as the U.S. Geological Survey reported for karst aquifers in Tennessee[27] (Appendix 18) as follows:

> *Chlorinated solvents are widely used in many industrial operations. High density and volatility, low viscosity, and solubilities that are low in absolute terms but high relative to drinking water standards make chlorinated solvents mobile and persistent contaminants that are difficult to find or remove when released into the groundwater system. The major obstacle to the downward migration of chlorinated solvents in the subsurface is the capillary pressure of small openings. In karst aquifers, chemical dissolution has enlarged joints, bedding planes, and other openings that transmit water. Because the resulting karst conduits are commonly too large to develop significant capillary pressures, chlorinated solvents can migrate to considerable depth in karst aquifers as dense nonaqueous-phase liquids (DNAPL's). Once chlorinated DNAPL accumulates in a karst aquifer, it becomes a source for dissolved-phase contamination of ground water. A relatively small amount of chlorinated DNAPL has the potential to contaminate ground water over a significant area for decades or longer.*

The unnecessary risks of introducing hazardous contaminant sources into the sensitive "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area require a different alternative location. This road project can easily avoid the limited area with highly developed karst and the sensitive "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area by shifting the location to the south.

The Council on Environmental Quality's *Regulations For Implementing The Procedural Provisions Of The National Environmental Policy Act* clearly require agencies base their decisions on a full understanding of the environmental consequences as follows:

> *40 CFR §1500.1 Purpose.*
>
> *(b) NEPA procedures must insure that environmental information is available to public officials and citizens* ***before decisions are made and before actions are taken****. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny* ***are essential to implementing NEPA****. Most important, NEPA documents* ***must concentrate on the issues that***

[27] Quote is from page 1 of Wolfe, William John, et al. *Preliminary conceptual models of the occurrence, fate, and transport of chlorinated solvents in karst regions of Tennessee*. No. 97-4097. US Geological Survey; Branch of Information Services [distributor],, 1997.

> ***are truly significant to the action in question***, *rather than amassing needless detail.*
>
> *(c) Ultimately, of course, it is not better documents but better decisions that count. NEPA's purpose is not to generate paperwork—even excellent paperwork—but to foster excellent action. The NEPA process is intended to help public officials make decisions that are* ***based on understanding of environmental consequences****, and* ***take actions that protect****, restore, and enhance the environment. These regulations provide the direction to achieve this purpose.*
>
> *Part 1502—Environmental Impact Statement*
>
> *40 CFR §1502.14 Alternatives including the proposed action.*
>
> *This section is the* ***heart of the environmental impact statement****. Based on the information and analysis presented in the sections on the Affected Environment (§1502.15) and the Environmental Consequences (§1502.16), it should present the* ***environmental impacts of the proposal and the alternatives*** *in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public.*

Regulations of the Council on Environment Quality implemented Public Law 91–190, title I, § 102 of the National Environmental Policy Act telling federal agencies what they must do to comply with the procedures and achieve the goals of the Act, see *Andrus v. Sierra Club*, 442 U.S. 347, 99 S. Ct. 2335, 60 L. Ed. 2d 943 (1979) as follows:

> The thrust of § 102 (2) (C) is thus that environmental concerns be integrated into the very process of agency decision-making. The "detailed statement" it requires is the outward sign that environmental values and consequences have been considered during the planning stage of agency actions. If environmental concerns are not interwoven into the fabric of agency planning, **the "action-forcing" characteristics of § 102 (2) (C) would be lost**. "In the past, environmental factors **have frequently been ignored and omitted from consideration** in the early stages of planning . . . . As a result, unless the results of planning are radically revised at the policy level— and this often means the Congress— environmental enhancement opportunities may be foregone and unnecessary degradation incurred." S. Rep. No. 91-296, supra, at 20. For this reason **the regulations of the Council on Environmental Quality (CEQ) require federal agencies to "integrate the NEPA process with other planning at the earliest possible time to insure that planning and decisions reflect environmental values** . . . ." 43 Fed. Reg. 55992 (1978) (to be codified at 40 CFR § 1501.2).

My FOIA request for all records specifically includes all records regarding the analysis of alternatives to avoid adverse impacts of KY 3005 (Ring Road) Extension from Western

Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00 to the "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area and to the highly developed karst.

6. THE FEDERAL HIGHWAY ADMINISTRATION MAY NOT APPROVE THE USE OF A PROPERTY ON THE NATIONAL REGISTER OF HISTORIC PLACES UNLESS THERE IS NO FEASIBLE AND PRUDENT AVOIDANCE ALTERNATIVE.

The Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2) on page 4 under "B. Archeology/Historic Resources" shows "*Known Archeological or Historic Resources are present*" for the proposed KY 3005 (Ring Road) Extension Item No. 4-0198.00 and states "*The Hagan House and Farm are on the National Register of Historic Places*." The Federal Highway Administration recognizes that historic sites on the National Register of Historic Places are to receive the avoidance protections of Section 4(f) according to FHWA's July 20, 2012 *Section 4(F) Policy Paper*[28] on page 6 (Appendix 19) as follows:

> *Section 4(f) also applies to all historic sites that are listed, or eligible for inclusion, in the National Register of Historic Places (NR) at the local, state, or national level of significance regardless of whether or not the historic site is publicly owned or open to the public. ...*
>
> *Section 4(f) properties should be identified as early as practicable in the planning and project development process in order that complete avoidance of the protected resources can be given full and fair consideration (See 23 CFR 774.9(a)). Historic sites are normally identified during the process required under Section 106 of the NHPA and its implementing regulations (See 36 CFR Part 800). Accordingly, the Section 106 process should be initiated and resources listed or eligible for listing in the NR identified early enough in project planning or development to determine whether Section 4(f) applies and for avoidance alternatives to be developed and assessed (See 23 CFR 774.11(e)).*

[28] FHWA's July 20, 2012 *Section 4(F) Policy Paper* is available at https://www.environment.fhwa.dot.gov/4f/4fpolicy.asp

The avoidance protection provided to Section 4(f) properties is in 23 CFR § 774.3 as follows:

> *23 CFR § 774.3 Section 4(f) approvals.*
>
> *The Administration may not approve the use, as defined in § 774.17, of Section 4(f) property unless a determination is made under paragraph (a) or (b) of this section.*
>
> *(a) The Administration determines that:*
>
> *(1) There is no feasible and prudent avoidance alternative, as defined in § 774.17, to the use of land from the property;*

My FOIA request for all records specifically includes all records regarding alternatives to avoid adverse impacts of KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00 to historic properties.

7. THE U.S. ENVIRONMENTAL PROTECTION AGENCY PROVIDES REVIEW AND ASSISTANCE IN PLANNING KENTUCKY ROAD PROJECTS AS NEEDED.

The Radcliff/Elizabethtown Metropolitan Planning Organization's *Unified Planning Work Program, Fiscal Year 2014* states the U.S. Environmental Protection Agency may provide the Radcliff/Elizabethtown MPO with review and advisory assistance on an as needed basis on page 12 and 13 [29] (Appendix 20) as follows:

> *Other federal agencies such as the Federal Aviation Administration, US Army Corps of Engineers, Federal Railroad Administration, and Environmental Protection Agency may provide the Radcliff/Elizabethtown MPO with review and advisory assistance on an as needed basis.*

This Radcliff/Elizabethtown Metropolitan Planning Organization's *Unified Planning Work Program, Fiscal Year 2014* states one of the MAP 21 National Goals for the new performance-

[29] Radcliff/Elizabethtown Metropolitan Planning Organization's *Unified Planning Work Program, Fiscal Year 2014* is available at http://www.ltadd.org/pdf/MPO-WorkProgram-2014.pdf

based planning requirements is Environmental Sustainability on pages 14 and 15 [30] (Appendix 20) as follows:

> *Environmental Sustainability — To enhance the performance of the transportation system while protecting and enhancing the natural environment.*

Therefore if needed the U.S. Environmental Protection Agency provided review and advisory assistance in planning environmental protections for KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00.

The Federal Highway Administration and the Kentucky Transportation Cabinet reportedly use Context Sensitive Design and Context Sensitive Solutions for planning road projects[31] (Appendix 11) since at least 2002 as follows:

> *This is an advance over outdated agency processes in which engineers determine an alignment or plan, and then "after-the-fact" evaluate the plan for adverse environmental consequences. ...*
>
> *Despite budget and time constraints, it is critical to the success of the CSD/CSS (and NEPA) process to obtain information from the appropriate resource and regulatory agencies concerning problem definition, evaluation criteria, alternatives development, alternatives evaluation, and the identification of a preferred alternative. ...*
>
> *In Kentucky, the Transportation Cabinet created 12 staff positions to monitor all environmental activities at the District level. ... Kentucky also has established an Environmental Advisory Team, consisting of KTC staff, FHWA staff, and consultants to track environmental commitments and look for opportunities to streamline and improve the process. ...*

Accordingly the Federal Highway Administration recognizes the importance to consider all the environmental issues early in project design[32] (Appendix 11) as follows:

---

[30] Radcliff/Elizabethtown Metropolitan Planning Organization's *Unified Planning Work Program, Fiscal Year 2014* is available at http://www.ltadd.org/pdf/MPO-WorkProgram-2014.pdf

[31] Quoting from pages 35 and 37 of Carlson, E. Dean, et al. *National Cooperative Highway Research Program*, Report 480, 2002.

[32] Quoting from page 38 of Carlson, E. Dean, et al. *National Cooperative Highway Research Program*, Report 480, 2002.

> *Scoping is an excellent opportunity to make sure that environmental considerations are not an after-thought in developing and evaluating alternatives, and to ensure that all of the relevant information is on the table early in the project so all of the trade-offs can be considered.*

However, the Kentucky Transportation Cabinet District 4's June 2012 *Data Needs Analysis Scoping Study* (Appendix 2) fails to include environmental consideration of the "*Gaither Spring*" (also known as "*Dyers Spring*") Wellhead Protection Area and of the highly developed karst.

My FOIA request for all records specifically includes all records of U.S. Environmental Protection Agency communications with the Radcliff/Elizabethtown Metropolitan Planning Organization, with the Lincoln Trail Area Development District, with the Elizabethtown/Hardin County Industrial Foundation, with the City of Elizabethtown Kentucky officials, with Hardin County Kentucky officials, with other local government officials, with the Kentucky Division of Water, with the Kentucky Transportation Cabinet, with the Kentucky Cabinet for Economic Development, with other state agencies, with Kentucky State legislators, with Kentucky State officials, with the U.S. Geological Survey, with the Federal Highway Administration, with the U.S. Army Corps of Engineers, with the Council on Environment Quality, with other Federal Agencies, with Kentucky Federal legislators, with HMB Professional Engineers, with QK4, and with other consultants regarding <u>KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00</u>.

8. MY FREEDOM OF INFORMATION ACT REQUEST REASONABLY DESCRIBES THE RECORDS AND IS MADE IN ACCORDANCE WITH THE PUBLISHED RULES.

Decision makers and the public must have full disclosure of the environmental risks in order to evaluate the actual risks of this proposed project. The World Commission on the Environment and Development defined sustainable development as development that meets "*the needs and aspirations of the present without compromising the ability to meet those of the* *future*" and cautioned that "*environmental degradation can undermine economic development.*"[33] (Appendix 21). This wisdom for international development is equally applicable to this individual road project in Hardin County Kentucky.

President Obama's FOIA Memoranda[34] recognizes the Freedom of Information Act "*is a requirement of a democracy.*" The new directives require "*records should be reviewed in light of the presumption of openness with a view toward determining what can be disclosed, rather than what can be withheld.*" "*(T)he Guidelines stress that the President has directed agencies not to withhold information merely to prevent embarrassment, or because 'errors and failures might be revealed, or because of speculative or abstract fears.*'"

I request all records regarding KY 3005 (Ring Road) Extension from Western Kentucky Parkway to I-65 and 31-W including a new interchange with I-65, Item No. 4-0198.00. I understand that there may be fees and costs associated with my FOIA request and I agree to pay any fees and costs up to $2,000 (two thousand dollars) associated with making these records available to me. If the fees and costs will be in excess of $2,000 (two thousand dollars), please advise me before such fees and costs are incurred.

Please email me at patragland@outlook.com in case you need to communicate with me about my request.

Sincerely,

Pat Ragland

Pat Ragland
PO Box 2725
Elizabethtown, KY 42702-2725
Email: patragland@outlook.com

[33] Quoting from pages 102 and 103 of Robinson, Nicholas A. "Law of Sustainable Development, The." *Pace. Envtl. L. Rev.* 13 (1995): 507.

[34] Department of Justice guidance on President Obama's FOIA Memoranda is available at https://www.justice.gov/oip/blog/foia-post-2009-creating-new-era-open-government

LIST OF APPENDICES

Appendix 1 - *Ring Road Extension Hardin County*, Kentucky Transportation Cabinet, Department of Highways, Division of Planning, November 1987.

Appendix 2 - *Data Needs Analysis Scoping Study, KY 3005, Hardin County From WK Parkway to I-65*, Item No. 4-198.00, Prepared by KYTC District 4-Charlie Allen, June 2012.

Appendix 3 - Taylor, Charles J. *Delineation Of Ground-Water Basins And Recharge Areas For Municipal Water-Supply Springs In A Karst Aquifer System In The Elizabethtown Area, Northern Kentucky*. U.S. Geological Survey Water-Resources Investigations Report 96-4254 pages 1 through 3.

Appendix 4 - Mull, Donald S., James L. Smoot, and Timothy D. Liebermann. *Dye tracing techniques used to determine ground-water flow in a carbonate aquifer system near Elizabethtown, Kentucky*. No. 87-4174. US Geological Survey,, 1988, pages 58 and 59.

Appendix 5 - *The Commonwealth of Kentucky 1993 Wellhead Protection Program*, February 1993, pages 19, 33 through 37.

Appendix 6 - United States Department of Transportation, Federal Highway Administration (2012), *Is Highway Runoff a Serious Problem?*, FHWA Environmental Technology Brief, Publication Number: FHWA-RD-98-079.

Appendix 7 - Renken, Robert A., et al. *Pathogen and chemical transport in the karst limestone of the Biscayne aquifer: 1. Revised conceptualization of groundwater flow.* Water Resources Research 44.8 (2008), page 1.

Appendix 8 - Memorandum (R-066-2014) *Geotechnical Engineering Roadway Report, Ring Rd. Extension: Western KY Pkwy to I-65, Item No. 4-198.00,* January 26, 2016, pages 1 through 3 and plan map.

Appendix 9 - *EPA Comments Concerning the I-69 Evansville to Indianapolis, Tier 2 Draft Environmental Impact Statement, Section 4 – Crane NSWC to Bloomington, Indiana*, CEQ No. 20100281, pages 14, 15 and 25.

Appendix 10 - U.S. Geological Survey "Circular 968" by Newton, John G. *Development of sinkholes resulting from man's activities in the eastern United States*. No. 968. USGPO,, 1987, pages 39 and 40.

Appendix 11 - Carlson, E. Dean, et al. *National Cooperative Highway Research Program*, Report 480, "A Guide to Best Practices for Achieving Context Sensitive Solutions", 2002, pages 35 through 42.

Appendix 12 - Photograph of Dishman Lane Collapse on the Kentucky Geological Survey's chart "*Geologic Hazards in Kentucky*". Carey, Daniel I., Terry D. Hounshell, and John David Kiefer. *Geologic Hazards in Kentucky*. University of Kentucky, Kentucky Geological Survey, 2008.

Appendix 13 - "Case Study # 2, Collapse sinkhole at Dishman Lane, Kentucky" on pages 277 to 282 of Waltham, Tony, Fred Bell, and Martin Culshaw. *Sinkholes and subsidence: Karst and Cavernous Rocks in engineering and construction*. Environmental & Engineering Geoscience 11.2 (2005): 180.

Appendix 14 - FEMA's Environmental Assessment Quiggins Sinkhole Flood Mitigation Project, *City of Radcliff, Hardin County, Kentucky*, DR-KY-1818-0012, February 12, 2015, pages 1 through 4 along with QK4, Louisville, Kentucky, *Quiggins Hydrologic Study,* 2009, page 29.

Appendix 15 - Kentucky's karst Best Management Plan (BMP) *Design Memorandum No. 12-05.*

Appendix 16 - Buckler, D. R., and G. E. Granato, 1999, *Assessing biological effects from highway-runoff constituents,* U. S. Geological Survey "Open-File Report 99-240", pages 5 and 6.

Appendix 17 - Fisher, R. Stephen, Bart Davidson, and Peter T. Goodmann. *Groundwater Quality in Watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek* (Kentucky Basin Management Unit 5). Kentucky Geological Survey, University of Kentucky, 2008, page 11.

Appendix 18 - Wolfe, William John, et al. *Preliminary conceptual models of the occurrence, fate, and transport of chlorinated solvents in karst regions of Tennessee*. No. 97-4097. US Geological Survey; Branch of Information Services [distributor],, 1997, page 1.

Appendix 19 - Federal Highway Administration, *Section 4(F) Policy Paper,* July 20, 2012, page 6.

Appendix 20 - Radcliff/Elizabethtown Metropolitan Planning Organization, *Unified Planning Work Program, Fiscal Year 2014*, 2013, pages 11 through 15.

Appendix 21 - Robinson, Nicholas A. "Law of Sustainable Development, The." *Pace. Envtl. L. Rev.* 13 (1995): 507, pages 102 and 103.

Appendix 1

RING ROAD EXTENSION
Hardin County

KENTUCKY TRANSPORTATION CABINET
DEPARTMENT OF HIGHWAYS
DIVISION OF PLANNING

November , 1987

21

RING ROAD EXTENSION
HARDIN COUNTY

I. PURPOSE

This study identifies an alignment that extends Ring Road (which skirts Elizabethtown, Hardin County) from US 62 to the Western Kentucky Parkway (WKP). It also discusses the need for an extended section between WKP and US 31W. This extension is expected to open the undeveloped area to development both industrial and residential.

II. EXISTING CONDITIONS

At present, Ring Road begins at US 62 East just inside the Elizabethtown Urban Limits (as shown in Exhibit 1) continuing counterclockwise around Elizabethtown to US 62 West. It is a two-lane rural facility on four-lane right of way with the exception of a 1.5 mile 4-lane (undivided) section between Bewley Hollow Road and I-65.

III. SYSTEMS

Existing Ring Road is on the Federal-aid Urban and State Secondary Systems. The route is also classified as a Minor Arterial Street on the 1987 Functional Classification System.

The proposed extension from US 62 to US 31W is outside the urban boundary (see Exhibit 2) and would be placed on the Federal-aid and State Secondary Systems and classified a Rural Major Collector.

IV. PROPOSED ALIGNMENT

Utilizing a USGS quadrangle map, 1986 aerial photography, field reconnaissance along with as-built plans, the alignment shown on Exhibit 3 was developed. The alignment includes interchanges at WKP and I-65, with the remaining crossroads at grade. A grade separation and at-grade crossing of the CSX Railroad are also addressed. Gaithers Station Road will have to be relocated to achieve better sight distance. In the area of the railroad, several transmission lines cross the alignment. In these areas, the profile was held as close to the existing ground line as possible (assuming 22' transmission line height) to obtain the necessary clearance.

The extension is proposed to have a 60 mile per hour (mph) design speed and a rural two-lane initial paving on a four-lane ultimate graded typical section (40-foot depressed median, refer to Exhibit 4).

A. Section I

Section 1 begins at the US 62 - Ring Road Intersection as shown in Exhibit 3, traversing east crossing the CSX Railroad at grade or with a grade separation. The eastern terminus is a full diamond interchange with WKP, approximately 2.3 miles south of the US 31W Bypass Interchange.

This section is 1.80 miles in length and has the following cost breakdown. These estimates are based on 1986 average unit bid prices for all projects and are preliminary in nature. The four-lane right of way is estimated to take 20 parcels with two residential relocations. The utility estimates involve several overhead transmission lines with the relocation of one steel tower. These estimates are based on two-lane initial paving on a four-lane ultimate graded typical section (Exhibit 4).

	Railroad At-Grade Crossing	Railroad Grade Separation
Preliminary Engineering*	$ 318,000	$ 451,000
Utilities	471,000	309,000
Right of Way	452,000	452,000
Grade and Drain	1,636,000	3,285,000
Surfacing	556,000	556,000
Bridges	956,000	1,523,000
Interchange Ramps**	2,000,000	2,000,000
Relocation of Gaithers St. Road	150,000	150,000
Total Construction***	$5,298,000	$7,514,000
Total	$6,539,000	$8,726,000

* 6% of construction estimate.

** Cost of four ramps estimated from previous interchange studies.

*** Includes 20% for engineering and contingencies.

B. <u>Section 2</u>

This section begins at the proposed Ring Road - WKP Interchange and continues southeast crossing Glendale Road approximately 2.3 miles from its interchange with the US 31W Bypass. The proposed 2.08-mile alignment ties into I-65 with a diamond interchange to allow for an eventual at-grade intersection with US 31W. The location of the proposed interchange with I-65 permits future extensions to occur with minimal damage..

This proposed extension from WKP to US 31W presents a major problem with the existing weigh station on I-65 (just north of the proposed interchange). First, the ramp lengths required for the Ring Road Interchange overlap into the weigh station ramps. Even if the interchange were moved further south, the ramps of each interchange would be too close. Secondly, the extension of Ring Road to US 31W would give the trucks an alternate route to using the mandatory weigh station on I-65. Therefore, if Ring Road is extended to US 31W, the existing I-65 weigh station would need to be relocated with a minimum estimated cost of $2,000,000.

The following estimates for Section II are based on a two-lane initial paving on a four-lane ultimate graded section as in Section I.

Preliminary Engineering*	$ 421,000
Utilities	133,000
Right of Way**	635,000
Grade and Drain	1,800,000
Surfacing	644,000
Bridges	569,000
Interchange Ramps***	2,000,000
Weigh Station Relocation	2,000,000
Total Construction****	$7,013,000
Total	$8,202,000

* 6% of the construction estimate.

** 20 parcels and 3 residences.

*** 4 ramps at I-65.

**** Includes 20% for engineering and contingencies.

V. TRAFFIC

The existing (1986) and design year (2010) traffic estimates were provided by the Division of Mass Transportation. The truck percentages were furnished by the Division of Planning's Traffic Section.

The traffic (refer to Exhibits 5 and 6) illustrates that if the extension ends at the WKP, 2010 ADT is 3,480 vehicles per day (vpd). Whereas, if the proposed extension is constructed to US 31W, the 2010 ADT for Section 1 would be 11,040 vpd. Therefore, from a traffic standpoint, the logical eastern terminus for the proposed Ring Road Extension is US 31W. Ramp volumes for I-65 and the WKP Interchanges with the extension are attached in the Appendix.

VI. INTERCHANGE SPACING

The Federal Highway Administration requires an interchange spacing of 1 mile in urban areas and 3 miles in rural areas. The proposed Ring Road extension - I-65 Interchange is outside the urban boundary and is approximately 1.5 miles to the nearest interchange (assuming the weigh station is relocated). However, it can be strongly argued that this area is quickly urbanizing and that a 1-mile spacing should apply. This report does not include a weave analysis for either interchange.

VII. CONCLUSIONS

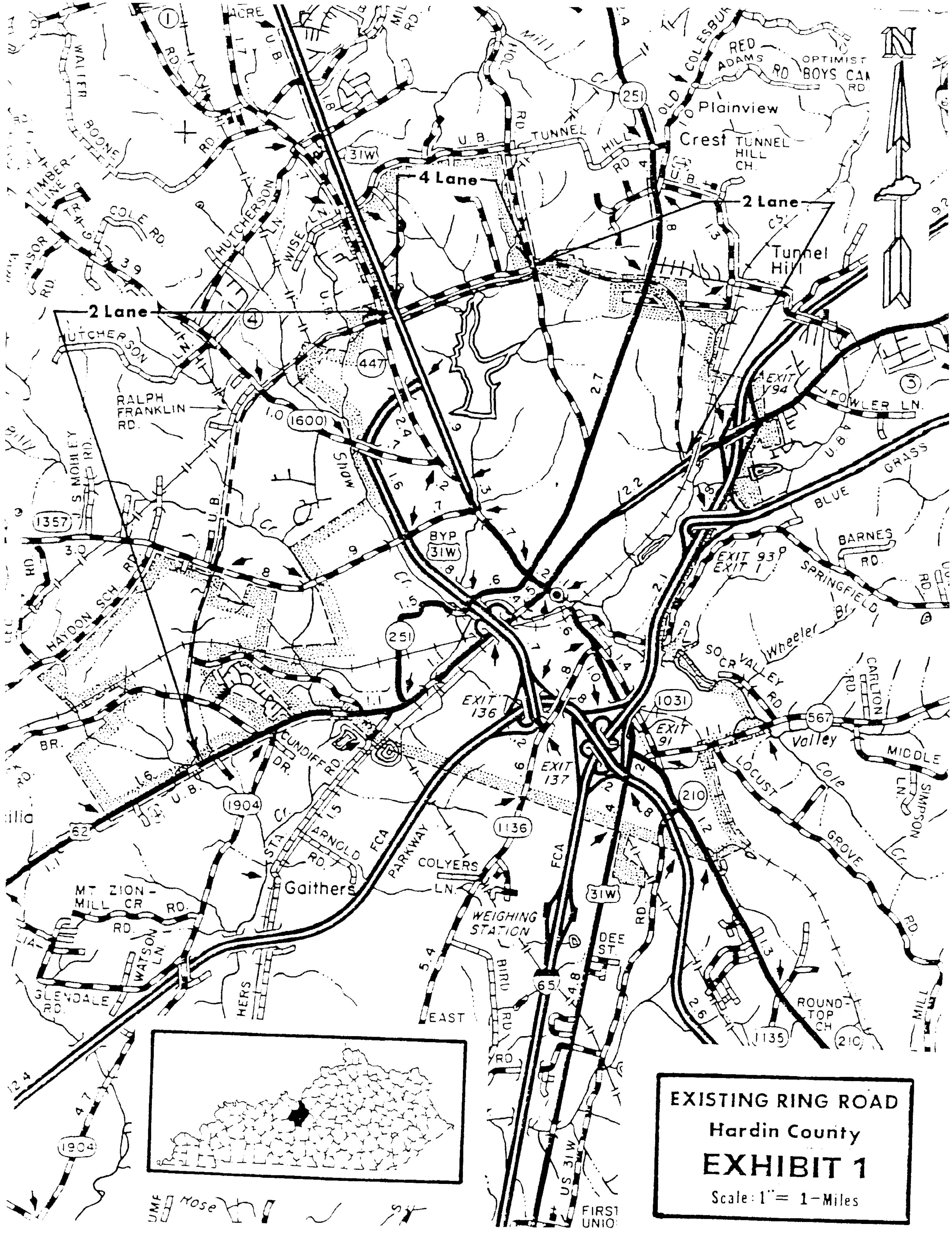
The proposed Ring Road Extension from US 62 to the WKP (Section 1) shown in Exhibit 3 has a 4-lane average right of way width of 225 feet. Several variations of cost estimates were prepared for this section and are located in Table 1 of the Appendix. Since the proposed roadway profile indicates the need for a large volume of borrow material, this study recommends constructing two lanes on a 4-lane graded section (see Exhibit 4) with an at-grade CSX Railroad crossing. The estimated cost of Section 1 with this description is $6,539,000 with 3,480 vpd in the year 2010.

The proposed Ring Road Extension from the WKP to US 31W, if constructed, increases the traffic on Section 1 to 11,040 vpd in the year 2010. The construction of Section 2 (WKP to US 31W) greatly enhances the feasibility of Section 1 from a traffic standpoint.

Again, the problem presented with Section 2 is the unavoidable relocation of the weigh station on I-65 which just recently received new weighing equipment. Section 2 with the same typical section as Section 1 has an average right of way width of 225 feet, length of 2.08 miles and an estimated cost of $8,202,000. The cost includes $2,000,000 for the weigh station relocation.

The total Ring Road Extension project from US 62 to US 31W would cost approximately $14,741,000 with an average right of way width of 225 feet. A partial control of access is recommended for this extension. A 1" = 200' aerial with proposed right of way limits, and further detailed work is available in the Division of Planning's Project Engineering Section.

EXHIBITS

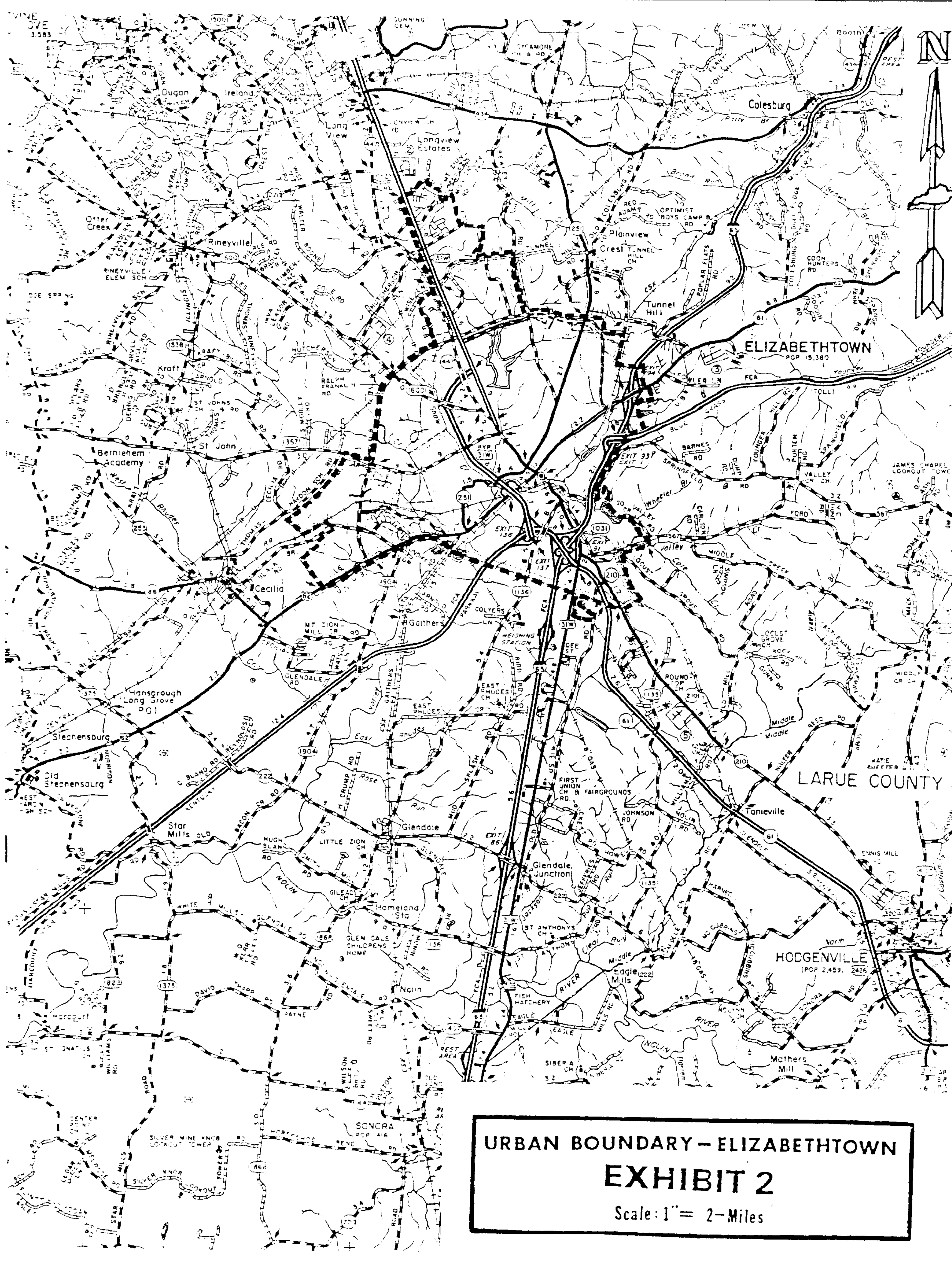


EXISTING RING ROAD

Hardin County

EXHIBIT 1

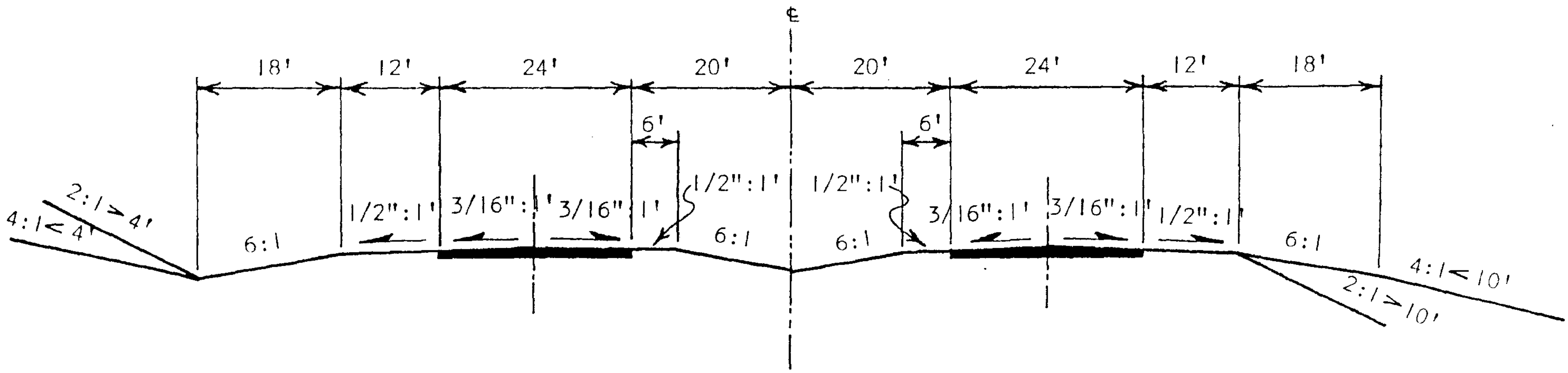
Scale: 1" = 1-Miles



URBAN BOUNDARY – ELIZABETHTOWN

EXHIBIT 2

Scale: 1" = 2-Miles



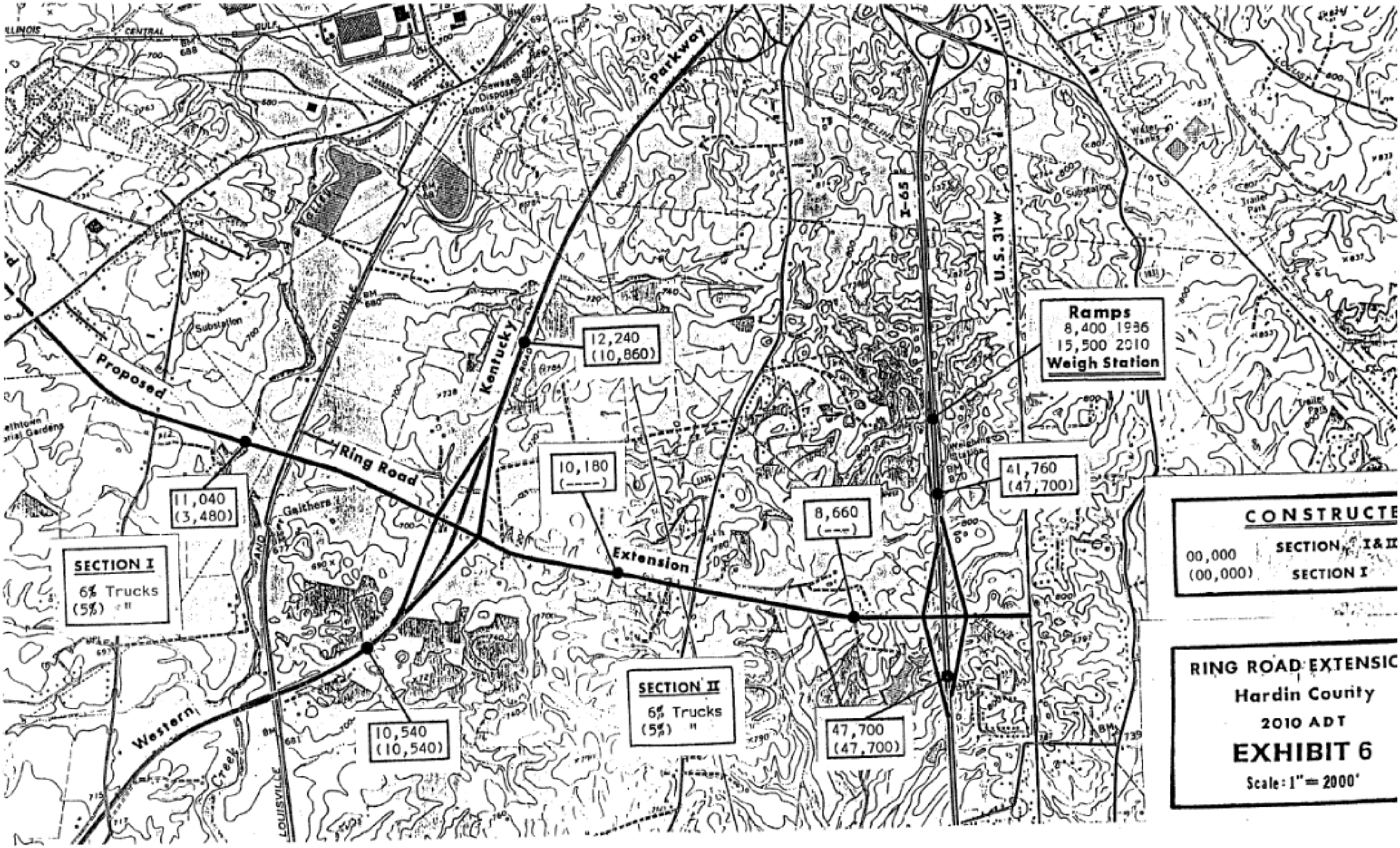
ULTIMATE TYPICAL SECTION

SCALE: 1"=20'

NOTE: Optional Initial 2-lane section constructed left of ultimate ℄.

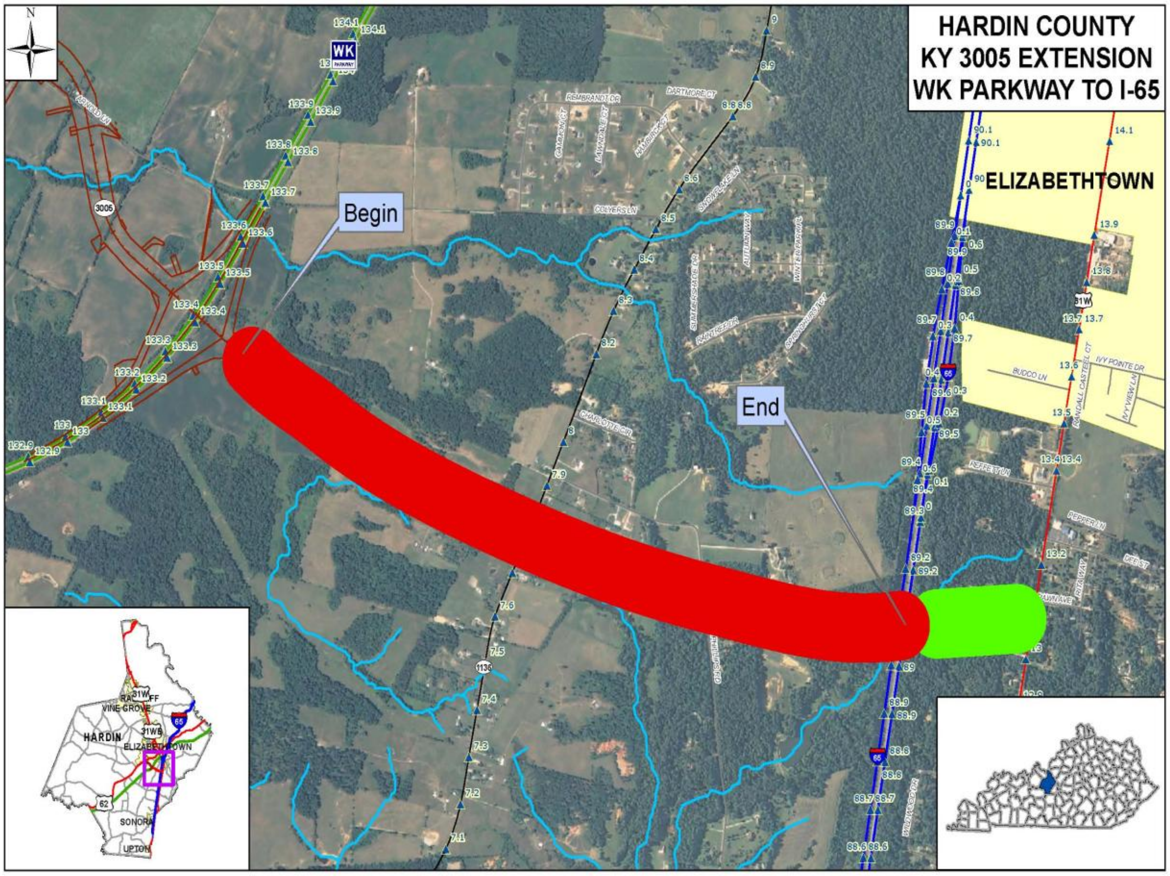
Typical Section subject to ...ing

RING ROAD EXTENSION
Hardin County
PROPOSED TYPICAL SECTION
EXHIBIT 4

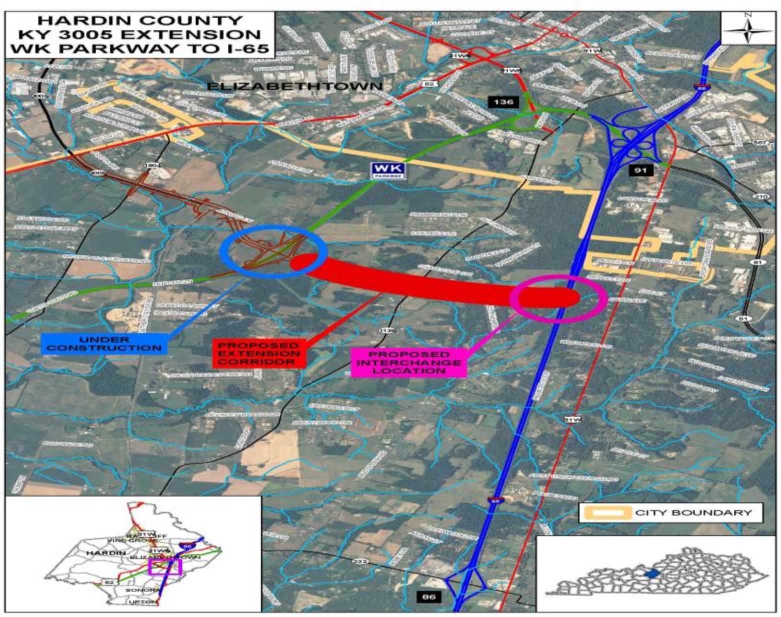

Parkway
Kentucky
I-65
U.S. 31w
Proposed
Ring Road
Extension
Western
Creek
Louisville
Nashville
Gaithers
Substation
Weigh Station
Ramps
8,400 1986
15,500 2010
Weigh Station
12,240
(10,860)
11,040
(3,480)
10,180
(-----)
8,660
(---)
41,760
(47,700)
10,540
(10,540)
47,700
(47,700)
SECTION I
6% Trucks
(5%) "
SECTION II
6% Trucks
(5%) "
CONSTRUCTE
00,000
(00,000)
SECTION I&II
SECTION I
RING ROAD EXTENSIC
Hardin County
2010 ADT
EXHIBIT 6
Scale: 1" = 2000'

Appendix 2

Data Needs Analysis



Scoping Study



KY 3005, Hardin County
From WK Parkway to I-65
Item No. 4-198.00

Prepared by KYTC
District 4-Charlie Allen

June 2012

KENTUCKY TRANSPORTATION CABINET

I. PRELIMINARY PROJECT INFORMATION

County:	Hardin	**Item No.:**	4-198.00
Route Number(s):	KY 3005	**Road Name:**	Ring Road
Program No.:		**UPN:**	(Function) 47 3005 (MPs)
Federal Project No.:		**Type of Work:**	PE & Environmental

2012 **Highway Plan Project Description:**

PRELIMINARY ENGINEERING FOR THE EXTENSION OF RING ROAD FROM THE WESTERN KENTUCKY PARKWAY TO I-65.

Beginning MP: **Ending MP:** **Project Length:** 2 miles

Functional Class.: ☑ Urban ☐ Rural — Arterial

State Class.: ☑ Primary ☐ Secondary

Route is on: ☐ NHS ☐ NN ☐ Ext Wt

MPO Area: Radcliff/E-town

Truck Class.: AAA

In TIP: ☑ Yes ☐ No

% Trucks: 6.7

ADT (current): N/A

Terrain: Rolling

Access Control: ☐ None ☐ Permit ☐ Fully Controlled ☑ Partial Spacing:

Median Type: ☐ Undivided ☑ Divided (Type): 28' depressed

Existing Bike Accommodations: Shoulder **Ped:** ☐ Sidewalk

Posted Speed: ☐ 35 mph ☐ 45 mph ☐ 55 mph ☐ Other (Specify):

KYTC Guidelines Preliminarily Based on : **70** **MPH Proposed Design Speed**

Roadway Data:	**EXISTING**	**COMMON GEOMETRIC PRACTICES***
No. of Lanes	4	4
Lane Width	12	12
Shoulder Width	10' left,6' right	match
Max. Superelevation**	Field Meaure	8%
Minimum Radius**	Field Meaure	600
Maximum Grade	Field Meaure	6%
Minimum Sight Dist.	Field Meaure	495
Sidewalk Width(urban)	4'	5'
Clear-zone***	Field Meaure	

Existing Rdwy. Plans available?
☐ Yes ☑ No
Year of Plans: new

☐ **Traffic Forecast Requested**
Date Requested:

☐ Mapping/Survey Requested
Date Requested:
Type:

Project Notes/Design Exceptions?:

*Based on proposed Design Speed, **AASHTO's A Policy on Geometric Design of Highways and Streets, ***AASHTO's Roadside Design Guide

Bridge No.*:	(Bridge #1)	(Bridge #2)
Sufficiency Rating		
Total Length		
Width, curb to curb		
Span Lengths		
Year Built		
Posted Weight Limit		
Structurally Deficient?		
Functionally Obsolete?		

Existing Geotech data available?
☐ Yes ☑ No

*If more than two bridges are located on the project, include additions sheets.

II. PROJECT PURPOSE AND NEED

A. Legislation

The following funding was listed in the 2012 General Assembly's Enacted Highway Plan.

Funding	*Phase*	*Year*	*Amount*
SPP	DN	2014	$1,500,000

B. Project Status

Design funds for this project have been requested. There is currently a construction project to build Ring Road from Gaither Station Road to the WK Parkway (Item 4-7010.50) in the amount of $13,123,215.06.

C. System Linkage

This section of Ring Road (KY 3005) will continue the previous segment and provide a direct southen access point to I-65 therefore connecting the WK Parkway, the Industrial Park area along the south end of Ring Road and the western portion of US 62. This project could be extended further to US 31w and provide an alternate route during road closures.

D. Modal Interrelationships

This section is not included in any published bike routes. There are no railroad, transit, riverport or freight networks associated with this new section.

E. Social Demands & Economic Development

Major traffic generators in the area include the Elizabethtown Sports Park off of West Park Road that will open in 2012. The main entrance to this park will be at the Ring Road/West Park approach. Other generators include multiple factories along Ring and US 62. Central Hardin High School is also located just east on US 62. Other development areas are available along this corridor including an Industrial Park expansion that will have access to US 62 just west of Ring Road. Hardin County Planning shared their Economic, Zoning, and Housing Analysis and is available on the Division of Plannings website.

F. Transportation Demand

The last actual traffic count for the section of Ring Road south of St. Johns road was in 9589 in 2010. The traffic has only increase slightly since 2004 when the count was 9420.

II. PROJECT PURPOSE AND NEED (cont.)

G. Capacity

There are not any significant congestion issues on the portion of Ring Road south of St. Johns. The VSF is very low at around 0.25. A traffic forecast will be required for this portion of roadway. None of the adjacent roadways have capacity issues currently.

H. Safety

The CRF for the section of Ring Road south of St. Johns road is around 1.643. The majority of the accidents were at the intersections with US 62, St. Johns Road and Peterson Drive. Other adjacent routes with high CRF include US 62 from KY 3005 (MP 14.580) to Corporate Drive (MP 15.561) with a factor of 0.988. I-65 has a high CRF from MP 90.257 to 91.257 with a factor of 1.558.

I. Roadway Deficiencies

This is a new route so the primary focus will be to determine number of lanes, access restrictions, shoulder widths and other design criteria based on some preliminary modeling. The overall adequacy rating on I-65 and US 31 w in the study area are deficient. The number of lanes on I-65 and the shoulder widths on US 31w are the primary areas of concern.

Consultants shall be required to develop an Interstate Justification Study . The IJS fulfills the requirement by the FHWA that seeks an evaluation of impacts for all new requests for interstate access.

The existing southbound weigh station would have to be relocated and the functional classification of the Interstate would have to be changed to Urban to meet the 1 mile interchange spacing requirement.

Draft Purpose and Need Statement:

Need: Ring Road (KY 3005) is currently being extended to the WK Parkway. The 1987 Planning Study recommended this roadway be extended on to I-65 and beyond to US 31w. This would complete the final section of this project. Needs include connectivity for freight, mobility, and relief on I-65 during accidents.

Purpose: The purpose of this study is to improve the connectivity and mobiltiy between I-65 and US 31w to the south and east of Elizabethtown and to US 62 and I-65 north of town.

III. PRELIMINARY ENVIRONMENTAL OVERVIEW

A. Air Quality

Project is in: ☑ Attainment area ☐ Nonattainment or Maintenance Area ☐ PM 2.5 County

STIP Pg.#: **TIP Pg.#:**

The project will be added to the STIP and TIP when the documents are updated to include

B. Archeology/Historic Resources

☑ Known Archeological or Historic Resources are present

The Hagan House and Farm are on the National Register of Historic Places (**Environmental Map located on Division of Plannings website**). It is located North of where the interchange with the WK Parkway crosses. This will be either an EA or a CEIII project and will need a full baseline and effects analysis for historic resources and a Phase I Arch survey on the preferred alignment.

C. Threatened and Endangered Species

There is suitable forested habitat available within the project area. A Biological Baseline and Assessment will be required. Impacts can be mitigated through a Conservation MOA.

D. Hazardous Materials

☐ Potentially Contaminated Sites are present ☐ Potential Bridge or Structure Demolition

The area is mostly agricultural and residential. No Hazardous Materials are expected on this project.

E. Permitting

Check all that may apply: ☑ Waters of the US ☐ MS4 area ☐ Floodplain Impacts ☐ Navigable Waters of the US Impacts

Are 401/404 Permits likely to be required? ☑ Yes ☐ No Impacts to: ☐ Wetlands ☑ Stream/Lake/Pond

☐ ACE LON ☑ ACE NW ☐ ACE IP ☐ DOW IWQC ☐ Special Use Waters

There is at least one jurisdictional water within the project area. Depending on the impacts this will require a NW14 permit and if impacts are less than 300' can be satisfied with an ACE LON

F. Noise

Are existing or planned noise sensitive receptors adjacent to the proposed project? ☑ Yes ☐ No

Is this considered a "Type I Project" according to the KYTC Noise Analysis and Abatement Policy? ☑ Yes ☐ No

There are numerous residences throughout the project area that could be impacted by additional noise. This is a Type I project because it is new alignment. Noise analysis will be required.

G. Socioeconomic

Check all that may apply: ☐ Low Income/Minority Populations affected ☑ Relocations ☐ Local Land Use Plan available

There are likely to be relocations as a part of this project.

H. Section 4(f) or 6(f) Resources

The following are present on the project: ☐ Section 4(f) Resources ☐ Section 6(f) Resources

The Hagan House is on the National Register of Historic Places and includes the farm as well.

Anticipated Environmental Document: CE Level 3

IV. POSSIBLE ALTERNATIVES

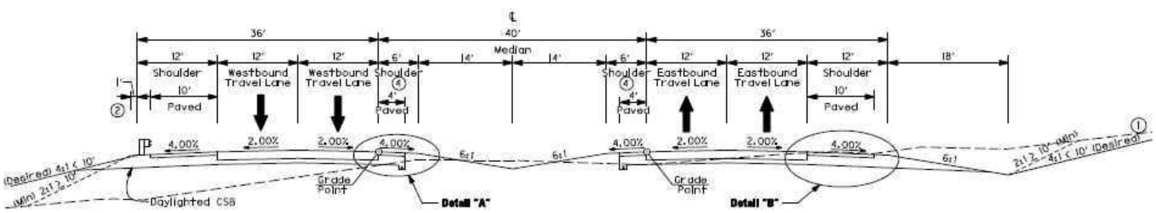
A. Alternative 1: No Build

This alternative should be carried forward, but does not address the needs identified. The IJS shall address necessary improvements to the existing network, KY 1136 and the WKP @ I-65 interchange.

B. Alternative 2

4 lane divided highway from WK Parkway to I-65 - 6 to 10 shoulders - New I-65 interchange would be 1.5 miles from the nearest interchange - Truck Weight Station would have to be moved South - At grade crossing of KY 1136 (New Glendale Road) - Match the existing typical section of the adjacent section that is under construction.

TYPICAL SECTIONS
RING ROAD (KY 3005)
MAINLINE



Planning Level Cost Estimate:

Phase	Estimate
Design	$1,500,000
R/W	$5,000,000
Utilities	$1,500,000
Const	$26,000,000
Total	**$34,000,000**

A 24" gas main is located just to the east of I-65 near the proposed ramp location. A new 24" water line is currently being installed that will run along Overall-Phillips Road and may require encasement or relocation. See Exhibit #3

IV. POSSIBLE ALTERNATIVES (cont.)

B. Alternative #3

Same as Alternate #2 except this project would extend Ring Road onto US 31w which is an additional 1400' approximately.

Planning Level Cost Estimate:

Phase	Estimate
Design	$1,700,000
R/W	$6,000,000
Utilities	$1,500,000
Const	$29,000,000
Total	**$38,200,000**

The 24" gas main and 24" water line could be impacted by the extension onto US 31w. See Exhibit #3

V. Summary

This is a Data Needs Analysis (DNA) of a roadway project for the KY 3005 corridor in Hardin County, Item Number 4-198.00. The is a new alignment that will extend Ring Road from the WK Parkway ramp that is currently under construction and create a new interchange at I-65 approximately 1.5 miles south of the nearest interchange. There are several needs identified with this study including 1) Trucks hauling freight would have a more direct access to industrial sites in and around Elizabethown. 2) Ring Road would connect I-65 to the South of Elizabethtown to I-65 on the North side of town while also connecting major routes just as US 62, US 31w, St. Johns Road, E2RC and KY 251. 3) Provide an alternate route during times of Interstate closures.

Consultants shall be required to develop an Interstate Justification Study . The IJS fulfills the requirement by the FHWA that seeks an evaluation of impacts for all new requests for interstate access.
The existing southbound weigh station would have to be relocated and the functional classification of the Interstate would need to be changed to urban after the interchange is constructed.

Included in the alternatives were a no build recommendation, a extension to I-65 and an extenstion to US 31w , Alt #2 and #3 include a new I-65 interchange. Design funds have been programmed.

Alt #	Description	D ($)(Fund)	R ($)(Fund)	U ($)(Fund)	C ($)(Fund)	Total ($mil)
1	No Build	-	-	-	-	-
2	Ring Road Extension to I-65	1,500,000	5,000,000	1,500,000	26,000,000	34,000,000
3	Ring Road Extension to US 31w	1,700,000	6,000,000	1,500,000	29,000,000	38,200,000
-	Current Hwy Plan Estimated Cost	1,500,000				
-	Current Pre-Con Estimated Cost					

VI. Tables and Exhibits

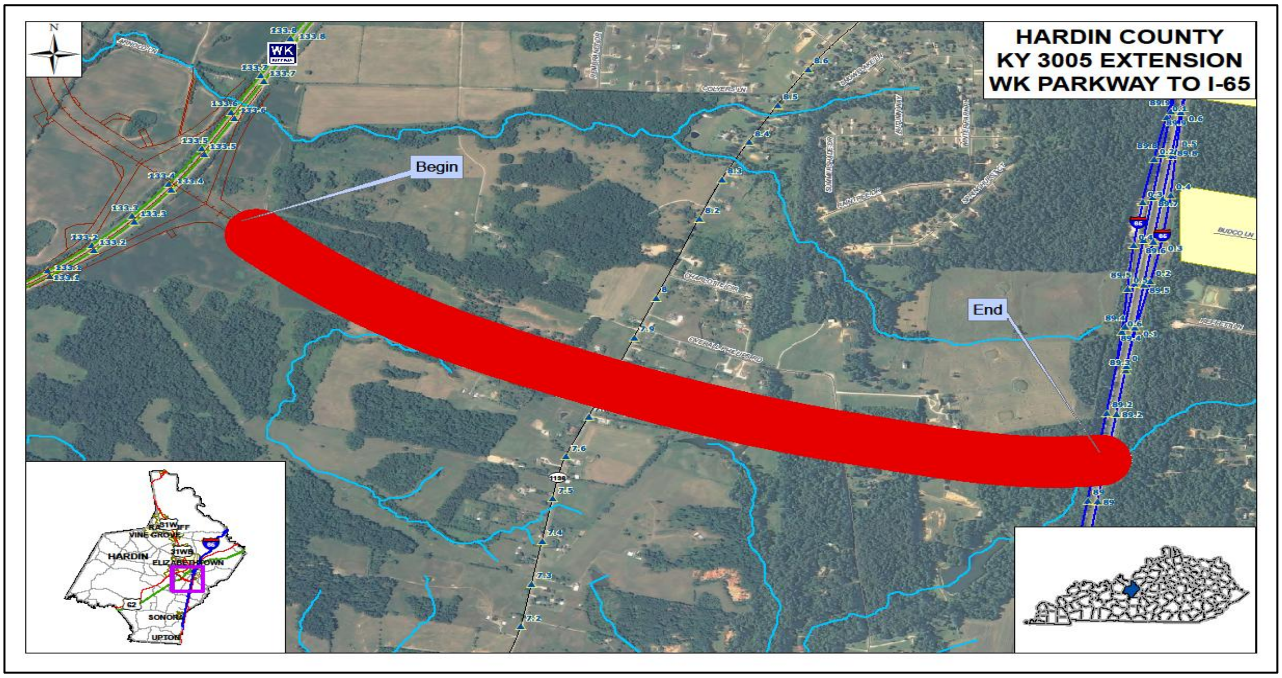


Exhibit 1: Project Location Map

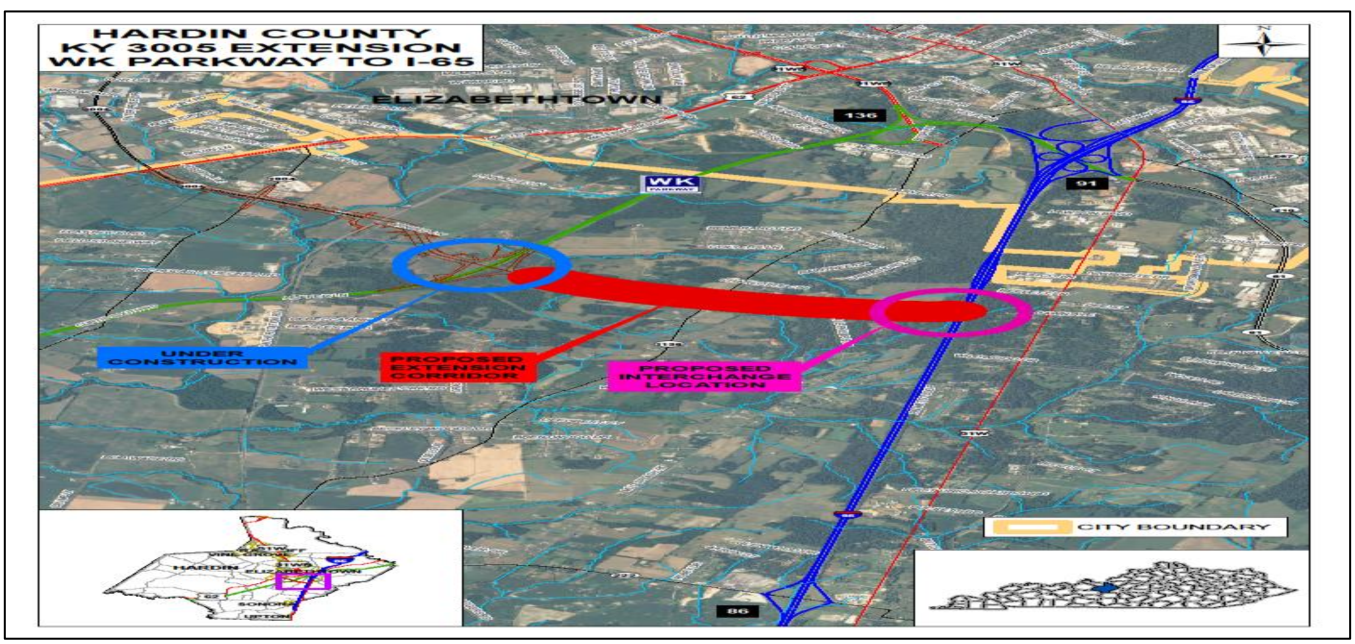


Exhibit 2: IJS Study Area

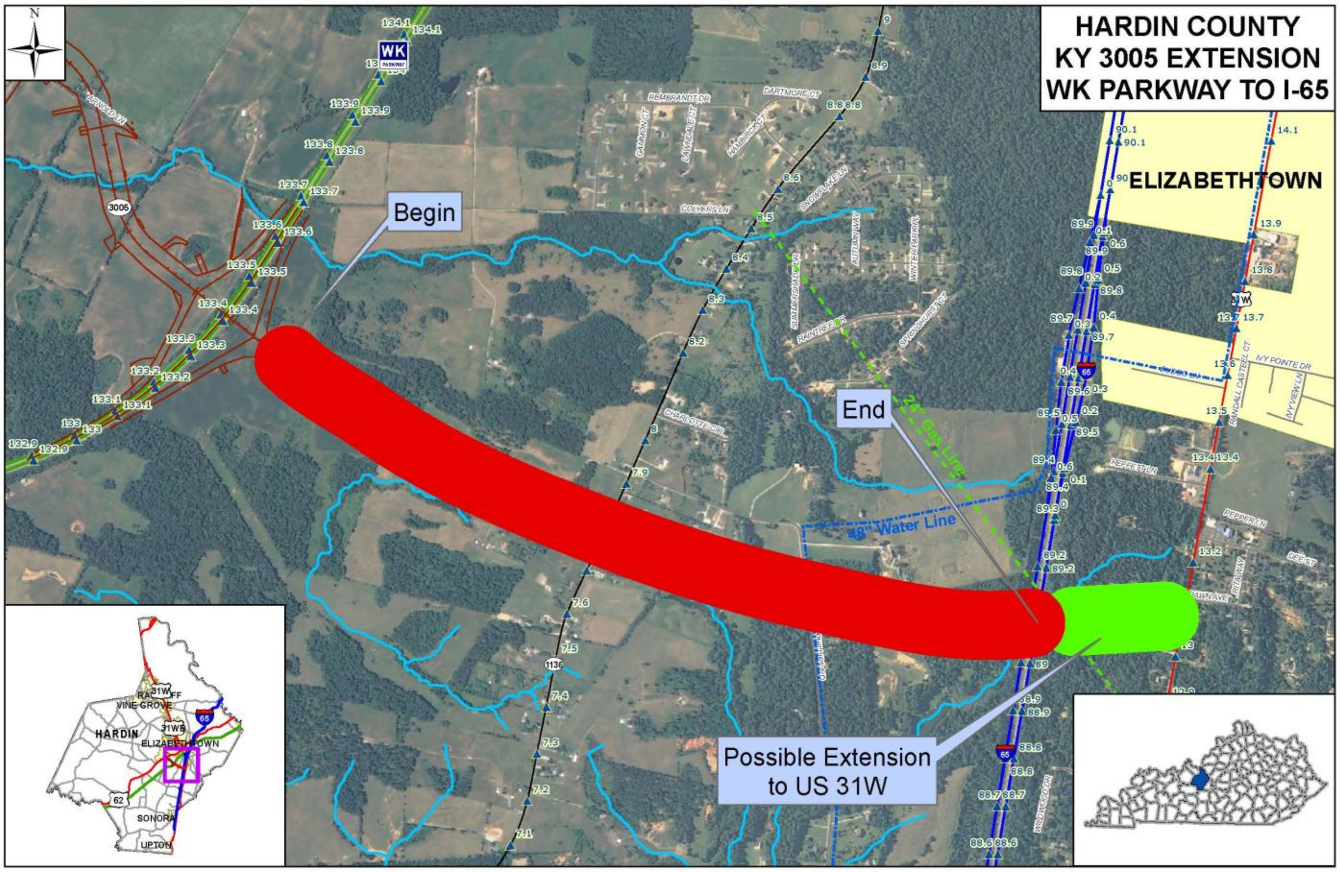


Exhibit 3: Utility Impacts Exhibit

Appendix 3

Delineation of Ground-Water Basins and Recharge Areas for Municipal Water-Supply Springs in a Karst Aquifer System in the Elizabethtown Area, Northern Kentucky

By CHARLES J. TAYLOR

U.S. Geological Survey
Water-Resources Investigations Report 96-4254

Prepared in cooperation with the
KENTUCKY DIVISION OF WATER,
DEPARTMENT OF ENVIRONMENTAL PROTECTION,
NATURAL RESOURCES AND
ENVIRONMENTAL PROTECTION CABINET

Louisville, Kentucky
1997

Delineation of Ground-Water Basins and Recharge Areas for Municipal Water-Supply Springs in a Karst Aquifer System in the Elizabethtown Area, Northern Kentucky

By Charles J. Taylor

Abstract

Ground-water basins and recharge areas for municipal water-supply springs for the Elizabethtown area, northern Kentucky, were delineated using a hydrogeologic-mapping approach, potentiometric map interpretation, and dye-tracing tests. Five distinct ground-water basins drained by major karst springs are present in the Elizabethtown area. These basins are composed of networks of hydraulically interconnected solution conduits and fractures. The boundaries of the basins for Elizabethtown and Dyers Springs—the primary sources of water for the city of Elizabethtown—were delineated by the positions of inferred ground-water divides on an existing potentiometric contour map. The results of dye-tracing tests, plotted as straight-line flowpaths, were used to confirm the presence and location of inferred ground-water divides and to adjust the position of the basin boundaries. Recharge areas of 4.8 and 2.7 square miles were delineated for Elizabethtown and Dyers Springs, respectively. Swallets that drain concentrated stormwater runoff from major highways are present in the recharge areas for both municipal-supply springs. Each spring is therefore potentially vulnerable to stormwater-runoff contaminants or accidental spills and releases of toxic or hazardous materials into certain highway drainage culverts.

INTRODUCTION

Springs are important sources of water supplies in the karst areas of Kentucky. A 1991 inventory reported that 25 different springs in 21 counties in Kentucky were used as public or semi-public water supplies (Kentucky Division of Water, 1991). Two springs in southeast Hardin County, Kentucky, Elizabethtown Spring (also known locally as City Spring) and Dyers Spring (Gaithers Station Spring), are used as the primary sources of municipal water for the City of Elizabethtown (fig. 1). About 1.4 Mgal/d is withdrawn from Elizabethtown Spring and about 567 Kgal/d is withdrawn from Dyers Spring during periods of highest consumptive use (Robert Best, Manager, Elizabethtown Water Plant, oral commun., 1995).

Conduit-dominated karst aquifers are widely recognized as being much more sensitive to ground-water contamination or degradation resulting from certain land-use practices than are typical granular and fractured-rock aquifers (Field, 1990). In recent years, considerable development of land for residential, industrial, and commercial uses has taken place in the Elizabethtown area, especially in and adjacent to sinkhole drainage areas known to be within the recharge areas of Elizabethtown or Dyers Springs.

Because of the concern for the increased potential for contamination and degradation of these two water-supply springs, the U. S. Geological Survey, in cooperation with the Kentucky Division of Water, Department of Environmental Protection, Natural Resources and Environmental Protection Cabinet, conducted an investigation to delineate the recharge areas of Elizabethtown and Dyers Springs and to gain a better understanding of the distribution and boundaries of the ground-water basins in the karst aquifer system

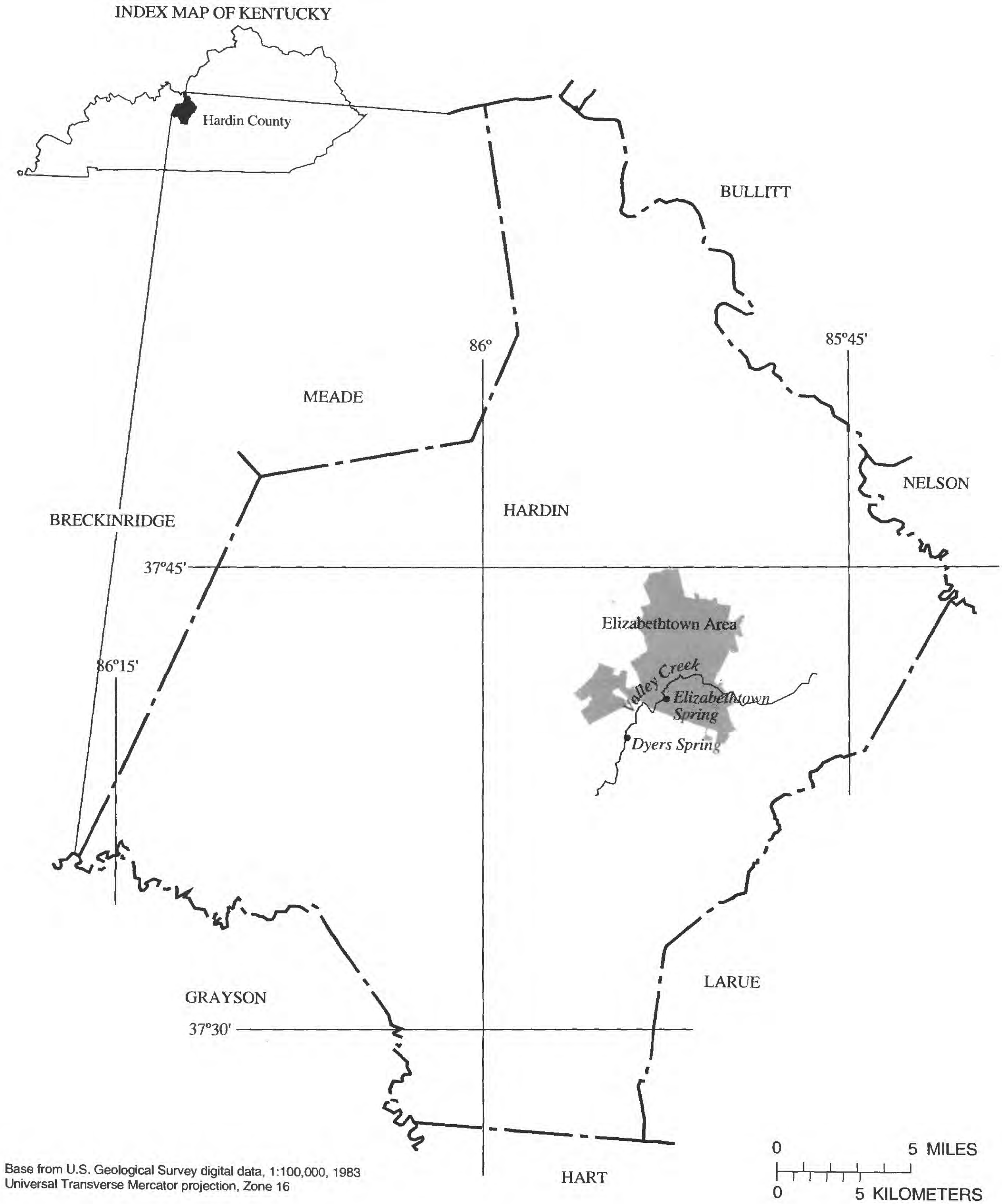


Figure 1. Location of study area and municipal water-supply springs, Elizabethtown area, northern Kentucky.

in the Elizabethtown area. This report presents the results of that investigation, which used a hydrogeologic-mapping approach that included potentiometric map interpretation and dye-tracing tests.

The information presented in this report is intended to aid water-supply managers and State regulators in developing a water-supply management and protection plan for Elizabethtown and Dyers Springs and to illustrate the use of hydrogeologic mapping methods to investigate the characteristics of karst aquifer systems.

Previous Studies

The stratigraphy and geologic structure of the Elizabethtown area are described on geologic quadrangle maps (1:24,000 scale) prepared by Kepferle (1963, 1966). A hydrologic atlas of the ground-water resources in a four-county area including Elizabethtown, Kentucky (Brown and Lambert, 1963), describes the lithologic and hydrogeologic properties of bedrock in the study area. Maps showing the altitude of the potentiometric surface of the shallow carbonate aquifer were prepared at a local scale of 1:24,000 by Mull and Lyverse (1984), at an intermediate scale of 1:50,000 by Lambert (1979), and at a regional scale of 1:250,000 by Plebuch and others (1985).

Lambert (1979), Mull and Lyverse (1984), and Mull and others (1988b) provide detailed information about the karst hydrology of the Elizabethtown area. Lambert (1979) describes the physiography and hydrogeology of southeastern Hardin and northeastern LaRue Counties, Kentucky, which includes the Elizabethtown area, and presents maps showing locations of major hydrologic features (springs and losing and gaining streams), spatial (geographic) variations in major-ion chemistry of water samples collected from wells and springs, and ground-water- level contours.

Mull and Lyverse (1984) describe the physical framework and hydrology of the karst aquifer system using hydrogeologic data obtained from geophysical logs of selected water wells, the results of aquifer (drawdown and recovery) tests, and discharge measurements of springs and surface streams. Discharge-rating curves for Elizabethtown and Dyers Springs were prepared using discharge measured during different hydrologic (flow) conditions. A map showing the altitude of the potentiometric surface prepared at 1:24,000 scale is included. The topographic and potentiometric contour lines depicted on this map illustrate the close correlation between topographic relief and the configuration of the potentiometric surface.

Mull and others (1988b) present the results of a series of qualitative and quantitative dye-tracing tests in the Elizabethtown area. Point-to-point subsurface flow connections are identified between certain sinkholes or sinking streams and each of the two water-supply springs. Dye-trace flowpaths are illustrated on a 1:24,000 scale map with potentiometric and topographic contour lines. In general, there is good agreement between the directions of ground-water flow indicated by the potentiometric contour lines and the plotted dye flowpaths. Dye-recovery (breakthrough) curves prepared from quantitative dye-tracing test results of Elizabethtown and Dyers Springs were used to evaluate solute transport characteristics, including traveltime, dilution, and dispersion properties. Smoot and others (1987) also discuss the relation between discharge and solute-transport characteristics of each spring.

Methods of Investigation

A hydrogeologic mapping approach was used to delineate karst ground-water basins and recharge areas of two municipal water-supply springs. Hydrogeologic mapping involves the identification of topographic, geologic, and hydrologic factors that affect ground-water occurrence and flow and is particularly applicable to investigations involving non-Darcian anisotropic aquifers (Bradbury and others, 1991). Combined use of field reconnaissance and mapping of karst drainage features, water-table or potentiometric-surface mapping, and dye-tracing has been successfully applied to delineate ground-water basins and the recharge areas of springs in different types of karst terranes (Thrailkill, 1985; Quinlan and Ewers, 1989; Bayless and others, 1994; Schindel and others, 1995).

Appendix 4

DYE TRACING TECHNIQUES USED TO DETERMINE GROUND-WATER FLOW IN A CARBONATE AQUIFER SYSTEM NEAR ELIZABETHTOWN, KENTUCKY

By D.S. Mull, J.L. Smoot, and T.D. Liebermann

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 87-4174

Prepared in cooperation with the

CITY OF ELIZABETHTOWN, KENTUCKY

Louisville, Kentucky

1988

Based on the results of these traces, the Elizabethtown Spring (site 1) is the major resurgence point for water draining underground at site 40 during both low and high flow conditions. Some water from site 40 also drains to sites 2 and 3. The significance of these results is that both the spring (site 1) and one well (site 3) used for public water supply by the city is recharged by drainage from the sinking stream (site 40) and that recharge to the well (site 3) from site 40 flows under, but does not intersect Valley Creek. Additional analysis of the quantitative data from these traces are discussed in a later section on the interpretation of dye-trace characteristics.

Seven quantitative traces were completed between Dyers Spring (site 16) and a karst window (site 15) about 3,000 feet east of the spring. The existence of this connection was suggested by Mull and Lyverse (1984) and was confirmed by qualitative traces on November 6, 1984 (trace 2).

In the karst window at site 15, a spring emerges from crevices in limestone at the upper end of the sinkhole, flows about 250 feet and drains into a swallet at the lower end of the sinkhole. The stream is about 40 feet below the surrounding farmland and is unused except for watering livestock, which have direct access to the spring. The area draining to the spring collects runoff from the adjacent farmland, which is cultivated for corn, soybeans, and various cover crops.

Although limestone is exposed at the lower end of the sinkhole, the mouth of the swallet was covered by ponded water for all flow conditions observed during this investigation. There is no external drainage, thus, except for evaporative losses, all water that enters the depression, either as discharge from the spring or as surface runoff from the area draining into the sinkhole, eventually drains underground through the swallet. The karst window receives relatively little direct runoff because of the small area that drains directly into the sinkhole, but the contributing area is hydrologically important because the sinkhole offers a direct path to the subsurface for any contaminant placed in the area draining to the sinkhole. Thus, agricultural chemicals associated with nearby farming and farm-animal wastes can drain directly into the ground-water system. In the case of this karst window (site 15), both qualitative and quantitative dye traces showed that flow from this site resurges at Dyers Spring (site 16), which is part of the Elizabethtown water supply.

Dye was poured into the stream above the swallet during each quantitative trace from site 15. All dye drained underground minutes after the injection except during traces 17 and 18, which were made during high base-flow conditions when the sinkhole was partly flooded. Automatic samplers collected water samples at Dyers Spring (site 16) and at the Elizabethtown Spring (site 1) during all traces from the karst window at site 15. In addition, passive detectors were installed in Valley Creek upstream of each spring. Dye injected into the karst window at site 15 was not recovered in Valley Creek nor from any other monitored site other than Dyers Spring. The fact that dye injected in site 15 was only recovered from Dyers Spring indicates that Dyers Spring is the major discharge point for the conduit system draining site 15 and also confirms that the ground-water basins draining to the Elizabethtown Spring and Dyers Spring are not interconnected, at least not under flow conditions that existed during dye traces performed during this investigation.

The apparent traveltime for the leading edge of the dye cloud between the karst window, site 15 and Dyers Spring (site 16) were 5 and 24 hours for traces 18 and 23, respectively, based on the straight line distance of 3,000 feet. Based on the elapsed time between injection and the arrival of the leading edge of the dye cloud, the apparent ground-water velocity was 8.3 and 1.6 ft/min for these traces. Discharge from Dyers Spring during these traces was 4.7 and 0.53 ft^3/s, respectively. These results suggest a relation between traveltime and discharge that is discussed in greater detail in a later section on interpretation of dye-trace characteristics.

Flow from a second karst window (site 22) was traced (trace 24) to Stark's Spring (site 21) on the west bank of Billy Creek upstream of the bridge at State highway 1357. The depression around the karst window (site 22) drains a relatively small area of pasture and woodland. Water in the karst window rises in a blue-hole spring and flows about 150 feet to swallets that are partly covered by debris. Water does not cover the swallets except during flooding. Unlike the karst window east of Dyers Spring (site 15), water can drain from this site when flood-water overtops the sinkhole, which is about 25 feet deep.

Trace 24 began at 1200 hours on January 22, 1986 when 200 mL of rhodamine WT was injected into the stream about 5 feet upstream of the swallets draining the karst window (site 22). The first arrival of dye was detected in water samples from Stark's Spring (site 21) 27 hours later. The peak dye concentration arrived 10 hours later. Measured discharge from Stark's Spring was 0.70 ft^3/s on January 23. The apparent ground-water flow velocity, based on the straight-line map distance of 7,100 feet between the karst window (site 22) and Stark's Spring (site 21), was about 4 ft/min. However, the actual velocity was likely greater, because the actual travel distance was probably greater than a straight line connecting the karst window (site 22) and Stark's Spring (site 21). Dye was recovered only from Stark's Spring at site 21 during both the qualitative trace 13 and the quantitative trace 24. It should be noted that passive detectors and water samples were used to monitor for dye in domestic supply wells in the vicinity of Stark's Spring 21 in addition to the city springs and wells and industrial supply wells. Dye from this injection was not found in water from any of these wells or springs. Also, dye was not detected by passive detectors or water samples from Billy Creek above the mouth of Stark's Spring. Based on these facts, Stark's Spring at site 21 is the major point of resurgence for ground-water flow from the karst window at site 22. This interpretation is further substantiated by analysis of the dye recovery data for trace 24 which is included in a later section on interpretation of dye-trace characteristics.

Miscellaneous Qualitative Traces

Identification of point to point connections between specific ground-water input and resurgence points, classified as qualitative traces, can be made with substances other than those specifically intended for ground-water tracing. Two traces of this type were observed during this investigation. In one instance, the tracer was dark-colored sediment and undefined organic material in the effluent from a malfunctioning wastewater lift station and in another case, the tracer was road salt contained in runoff from a salt-storage yard.

Appendix 5

THE COMMONWEALTH OF KENTUCKY

WELLHEAD PROTECTION PROGRAM

by

Kentucky Department for Environmental Protection

Division of Water, Groundwater Branch

Submitted to the U.S. Environmental Protection Agency
in fulfillment of the requirements of
Section 1428 of the Safe Drinking Water Act

February 1993

WELLHEAD PROTECTION AREA DELINEATION

The foremost goal of WHPA delineation is to protect wells, wellfields, and springs from the following three general contaminant threat categories:

1. Direct introduction of contaminants at the well or spring;
2. Microbial contaminants (bacteria and viruses); and
3. Chemical and radiological contaminants.

The state has chosen wellfield/spring basin management and remedial action to accomplish WHP goals. Wellfield/spring basin management involves delineating multiple WHPAs and assigning differential management strategies within each area. Specific management strategies are discussed in the Management Approaches section. Remedial action zones are established to protect the well or spring from unexpected contaminant releases and to minimize that likelihood by locating certain high-risk activities outside of the more sensitive WHPAs. The three WHPAs that will be established are:

1. WHPA-1, which encompasses the area directly adjacent to the well or spring which is designated to prevent direct introduction of microbial and chemical contaminants at the wellhead or spring;
2. WHPA-2, which is designated to prevent chemical and radiological sources from entering the groundwater system; and

MANAGEMENT APPROACHES

Implementing reasonable and effective management plans within WHPAs is a critical WHP goal. Attaining this goal will require cooperation and understanding between federal, state, and local governments and PWSs to protect groundwater in Kentucky. Most WHP situations require three WHPA boundaries to be established (WHPA 1, WHPA 2, WHPA 3). The local WHP plan shall present differential management strategies to control potential contaminant sources within each WHPA.

WHP MANAGEMENT OBJECTIVES

WHPA-1 encompasses the area directly adjacent to the well or spring. This area was designated to prevent direct introduction of microbial and chemical contaminants at the wellhead or spring. This is the most critical WHPA management area because a contaminant released in this area can be immediately drawn into the PWS distribution system with little reaction time available to begin groundwater remediation. Since WHPA-1 is limited in size, the management objective of WHP is to eliminate any incompatible contaminant sources. The ideal management goal is for the PWS or municipality to have controlling interest of this area. WHPA-1 can best be protected through acquisition by the PWS or municipality.

WHPA-2 was designated to prevent chemical and radiological sources from entering the groundwater system. Some contaminants are persistent in groundwater and may travel long distances. The

WHP management objective is to ensure that high quality potable water is available for future growth by controlling incompatible contaminant sources. Although some contaminant sources are compatible in this area, education and training for responsible parties should reduce the risk of an accidental contaminant release. High risk transportation corridors traversing WHPA-2 should be flagged for emergency response purposes. A strategy should be employed that minimizes the impact of illegal sinkhole dumps and abandoned wells to the aquifer.

WHPA-3 is the boundary marking the outer limits of the recharge area. This boundary is not required in certain circumstances due to specific aquifer characteristics. Management controls in WHPA-3 should direct the siting of incompatible potential sources of groundwater contamination outside of the recharge area and implement best management practices for existing sources. Pollution prevention strategies and public education will be the most effective management tool for protecting WHPA-3.

EXISTING MANAGEMENT PROGRAMS

There are a number of state agencies involved in regulating activities that directly or indirectly impacts groundwater. A summarized description of duties that these agencies perform is in Appendix F, which is taken from the 1987 Kentucky Groundwater Protection Strategy. These agencies can be contacted to determine if any regulated activities occur within delineated local WHPAs.

At the state level, the WHP program seeks to incorporate potential contaminant source control measures into other regulatory agency programs. Source control measures such as establishing permit guidelines for siting high-risk activities near approved WHPAs, limiting septic field density within WHPA-1, and discouraging sinkhole discharge will be initiated through memorandums of understanding and memorandums of agreement. Presently the need to establish specific inter-agency memoranda of understanding and agreement is not clear. Inter-agency memorandums will be drafted as local WHP projects demonstrate their need.

The state must continually review and revise existing groundwater protection policies and regulations. Currently, the Groundwater Branch is drafting groundwater classification and quality regulations that will strengthen existing groundwater protection strategies. The Groundwater Branch is also assessing aquifer vulnerability for the entire state.

All of the information associated with WHP such as locations of water sources, contaminant sources and dimensions of WHPA boundaries will be stored with other groundwater data in the states geographic information system (GIS) and in parameter specific databases. The GIS system is capable of plotting several different types of information in a scaled map format. The Groundwater Branch maintains databases that track groundwater quality, sources, and tracing results. This information is also plotted on 1:24,000 scale topographic maps for quick reference. This information will be used to direct the future siting of potential contaminant sources away from PWSs. All of this information is available to the public.

MANAGEMENT OF UNCONTROLLED SOURCES

Several potential sources of groundwater contamination are not adequately addressed by federal, state and local regulations. The most common of these sources are wrecking yards, hazardous materials and handling, quarries, road salt storage, agricultural activities, lawn care, and storm water management. The State WHP Program is committed to preparing guidelines that will enable local governments to incorporate these sources into an effective management plan.

MANAGEMENT PLANS

Managing potential contaminant sources in WHPAs is the responsibility of local government. For the most part, public water systems do not have any authority to manage sources outside their own property. This is why it is extremely important for the PWS and local government officials to work together on source management.

The Division of Water intends to provide technical, educational, and financial assistance to planning councils to develop management controls. Technical assistance may be provided by qualified groundwater personnel on-site during delineation phases when needed, as well as: laboratory facilities; groundwater related data bases; educational assistance provided through publications of groundwater related reports (bulletins and pamphlets); and training through special seminars, workshops, and classes. Limited financial assistance to the state WHP program development has been provided by EPA through Section 106 of the Clean Water Act. Funding for wellhead protection, when appropriated, can be obtained under the Water Supply Planning Requirements 401 KRS 4:220.

SUBMITTAL REQUIREMENTS

The local planning council shall submit detailed differential management strategies that are to be implemented for each WHPA. Submittal requirements for Phase II are:

1. Existing contaminant management programs;
2. Provide authority and responsible party(s) for each method;
3. Compliance and enforcement actions; and
4. Review, modification and update procedures.

Appendix 6

This techbrief is an archived publication and may contain dated technical, contact, and link information

Publication Number: FHWA-RD-98-079

FHWA Environmental Technology Brief

Office of Infrastructure R&D
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101

In cooperation with
Office of Environment and Planning
400 7th Street, SW
Washington, DC 20590

Is Highway Runoff A Serious Problem?

Not necessarily. Highway runoff may be a *potential* threat to receiving waters in your area, but if handled properly, it need not be a serious problem. Highway runoff is generally cleaner than runoff from buildings, farms, mines, harbors or other non-point sources. It is ironic, though, that despite the vast number of measures taken and resources invested to minimize its impact on receiving waters, highway stormwater runoff is still one of the most misunderstood and misrepresented contributors to water quality degradation.

'anything other than two atoms of hydrogen and one atom of oxygen is a water contaminant'

The potential threat of highway runoff on surrounding waters is not always certain for there are highly effective active and passive means to "treat" it before it actually causes any damage. Interestingly, some of the most effective treatments are passively present even when no deliberate actions are taken for mitigation. Highway runoff that soaks into soil with or without the presence of any type of vegetation, channel, or basin is usually harmless to the environment. Nonetheless, the implementation of vegetated swales and infiltration trenches along the roadside assures that highway runoff has time to settle and is filtered through grass and soil. Retention and detention basins, among other management practices, are highly effective means for controlling excessive flows of highway runoff. These devices capture highway runoff and release it at very slow rates, allowing sufficient time for heavier particles to settle out, evaporate, infiltrate or be absorbed.[1] Given that a large number of preventive and corrective measures can and are being taken to suppress the potential of any disturbing effects of highway runoff on nearby receiving waters, it is important to recognize that highway runoff need not be and most often is not a serious problem.

What's Contaminating Our Water?

Strictly speaking, anything other than two atoms of hydrogen and one atom of oxygen is a water contaminant. Contaminants become pollutants when they interfere with the normal life cycle functions of organisms living in or dependent on the water source. Contaminants come from a variety of point and non-point sources. Among the most significant point sources are industrial waste disposal sites, municipal landfills, leaking septic tanks, and occasional accidental spills of petroleum products and industrial liquids. Non-point sources, on the other hand, include agricultural runoff, mine drainage, urban and highway runoff, and runoff from lawns and natural areas. Non-point source pollution accounts for 80 percent of the degradation of waters in the United States.[2]

If left unchecked, non-point source pollution can damage the quality of receiving surface and ground waters. **Agricultural runoff**, for example, may carry nutrients, animal wastes, sediment, salts, pesticides, fertilizers, and other ingredients that may be harmful in high concentrations.[3] High concentrations of nutrients, for example, can stimulate excessive or undesirable forms of aquatic growth such as algae and noxious weeds. These plants may consume oxygen faster than natural processes can produce it and, as a result, fish and lower species in the food chain may be destroyed.[4] Nutrient enrichment can also drive up the pH levels in water through increased photosynthetic activity. Animal wastes can accelerate the production of algae and contaminate water used for fishing, swimming, and drinking with related microorganism pathogens.

Mine drainage often contains pyrites, which are sources of sulfuric acid and hydrogen sulfide that yield a smell of rotten eggs. When disturbed, pyrites weather and react with oxygen and water to lower pH levels. Low pH may lead to high levels of aluminum, iron, and manganese, which are toxic to fish and other aquatic species.[5]

At FHWA, we have successfully:

- Identified and quantified the constituents of highway runoff.
- Identified the sources of these pollutants and migration paths from the highway to the receiving water.
- Analyzed the effects of these pollutants on receiving waters.

We continue to:

- Develop the necessary analytical tool and abatement/treatment criteria and guidelines to minimize the effects of objectional constituents.

Our recommendations:

- Know the quality of the runoff and then design the treatment to fit the problem

Urban runoff from roads, parking facilities, sidewalks, buildings, rooftops, and other impervious surfaces can transport trash, debris, metals, hydrocarbons, and fecal matter that pollute receiving streams with pathogenic bacteria.[6] **Lawns and natural areas** may also contaminate runoff with nutrients, fertilizers, and suspended solids. Excessive concentrations of these microorganisms can prevent receiving water from being used for certain water supply and recreational activities.

Highway runoff can also have adverse effects if no measures are taken for the removal of excessive contaminants before the runoff reaches the receiving water. The most common contaminants in highway runoff are heavy metals, inorganic salts, aromatic hydrocarbons, and suspended solids that accumulate on the road surface as a result of regular highway operation and maintenance activities. Salting and sanding practices, for example, may leave concentrations of chloride, sodium, and calcium on the roadway surface. Ordinary operations and the wear and tear of our vehicles also result in the dropping of oil, grease, rust, hydrocarbons, rubber particles, and other solid materials on the highway surface. These materials are often washed off the highway during rain or snow storm events.

Receiving surface and ground waters are both susceptible to contamination from all these sources. Surface waters (streams, rivers, ponds, and lakes) are particularly vulnerable because they are directly exposed to contaminants released into the air and to direct discharges from point or non-point sources.[7] However, they have the benefit of being easily accessible for direct measurement and application of assessment techniques. Contamination of ground waters, on the other hand, tends to occur gradually because contaminants percolate downward through the soil at slow rates, where the ground serves as mother nature's filter. However, contaminants can also reach ground waters rather quickly through drainage entering fractured rock formations or sinkholes in Karst areas.[8] (Karst usually occurs in limestone areas and is characterized by caves, openings, and sinkholes.) Ground water is more sensitive to contamination in these areas because runoff may pass directly into the subsurface with little if any infiltration through the soil. Contamination of ground waters is less visible than that of surface waters, and, given that sampling and clean up is quite difficult and expensive, prevention of contamination is the most effective way of protecting them.

The presence of undesirable contaminants in surface or ground water may interfere with the vital functions of the organisms living in it or from it. There are, as discussed, a wide variety of point and non-point sources of pollutants, but only water quality evaluations can determine their actual role in the pollution of receiving waters. Treatment of runoff, if needed, should be a function of this water quality evaluation.

Are Waste and Recycled Materials Harmful to Receiving Waters?

FHWA is currently conducting studies to determine if, and to what extent, waste and recycled materials that may be used in highway construction could have adverse impacts on receiving waters, and to develop models that describe the transformation and fate of their ingredients.

The NCHRP Project 25-9, Environmental Impacts of Construction and Repair Materials on Surface and Ground Waters, is examining highway sites where waste materials like coal-ash, scrap rubber, and municipal solid waste, among many others, were used in the construction of fills and pavements.[9] Contrary to bioassay laboratory results indicating that these materials are indeed toxic, actual field studies have shown that, so far, none of them have had toxic effects on the quality of surrounding ground waters.[10] Additional analyses and laboratory scale tests will be performed to ascertain the differences between the laboratory and field test results, and to identify the mechanisms through which most of the tested materials lose their toxicity when under field conditions.

Studies on the Use of Waste and Recycled Materials are Being Conducted in Many States.
For Example:

Florida	Phosphogypsoum as sub-base material
Indiana	Foundry sands in fills
Maine	Rubber tire in fills
Minnesota	Recycled asphalt in pavements
New Hampshire	Municipal solid waste
Rhode Island	Crumb rubber in pavements
Virginia	Rubber tires in fills

Preliminary Results are Positive in all Studies

This project has revealed that toxic substances from waste materials can be eliminated after traveling short distances through typical roadside soils. However, research is still underway to assess the general water quality impacts from any of the materials studied by this and other research projects.

Ice & Snow Control Chemicals, for Better or for Worse?

For better. Much is written and said each winter about the effects of deicing chemicals on the environment, but little is said of their benefits to the millions of residents living in the northern portions of the United States. The truth is that deicing chemicals are essential to the safe transportation of goods and people across the nation.[11]

When applied heavily and frequently, deicing chemicals can pollute receiving waters, but the degree of their damage largely depends on the type and designated use of the receiving water, and on the drainage system used to discharge the runoff.

Surface waters are *not* as vulnerable to deicing chemicals as are ground waters because their turbulent actions blend and dilute plumes of incoming liquids almost immediately after the chemicals enter the main stream. Ground waters, on the other hand, are more susceptible to pollution since there may be no turbulent actions to dissolve the chemicals when the runoff percolates through the soil and enters the water table.[12]

Calcium Magnesium Acetate (CMA) and Potassium Acetate (KAc) are deicing chemicals most benign to the environment because they contain weak biodegradable acids.[13] Sodium Chloride (NaCl), Calcium Chloride ($CaCl_2$), and Magnesium Chloride (MgCl2), on the other hand, leave residues of chloride ions on the highway surface that may not only contaminate surrounding ground waters, but that may also corrode motor vehicles and bridge structures.

Nevertheless, the effect of deicing chemicals on receiving waters may vary with the specific use and overall ecological health of each particular water body. In some cases, water with elevated concentrations of sodium may be suitable for some uses but undesirable for certain industrial purposes. For example, high concentrations of sodium in water for human consumption are harmful to people with certain types of heart or kidney diseases, but the major objection to its use comes from the taste preference of the public. On the other hand, the effect of high salinity on fish life varies accordingly with the tolerance of individual fish species. Some fish cannot tolerate a salt level as low as 400 ppm, while others are able to live with levels higher than that of seawater (30,000 ppm.)[14] Salt levels in highway runoff vary with the amount of chemicals applied and the intensity of subsequent rainstorm events. Highway runoff can contain salt levels as low as 10 ppm, particularly in areas where deicing chemicals are not used.

Recent studies on the migration paths of deicing chemicals have indicated that, in places where highway runoff is discharged through open-drainage systems, as is typically done in many highways, concentrations of deicing chemicals tend to be substantially higher downgradient than upgradient from the highway. A study in Massachusetts revealed that chloride loads in ground water are reduced significantly when discharged through a closed drainage system, a closed drainage system with snow berm, and a full-snow-berm drainage system. Among these, the full-snow-berm drainage system has been found to be most effective in removing chloride loads from highway runoff.[15]

Deicing chemicals are often combined with other substances to prevent caking or inhibit corrosion. These substances may be toxic to human, animal, and fish life. Sodium ferrocyanide, for instance, is often used to prevent caking, but, unfortunately, releases cyanide ions that are extremely toxic to fish. Rust inhibitors, on the other hand, may contain phosphorus compounds that, in turn, stimulate the growth of undesirable aquatic plants, weeds and algae in fresh-water lakes.[13]

It is important to note that deicing chemicals in highway runoff are neither the only nor the major source of chloride contamination of the nation's waters. Sewage discharges and runoff from industrial waste and agricultural products also contain high concentrations of chloride that may affect receiving waters as well. Rain and snow may deposit as much as 35 to 40 lb of chloride per acre annually even without the presence of deicing chemicals. Areas that are geographically located along coastal waters also experience high chloride concentrations since chloride occurs naturally in sea water, natural brines, and water which passes through salt-bearing strata. Water quality analysis is needed so that any strategies for accommodation are tailored to the degree of contamination.

Are Heavy Metals in Highway Runoff Toxic to Aquatic Organisms?

Heavy metals in highway runoff are usually not a toxicity problem. Toxicity depends largely on the physical and chemical form of the heavy metals, their availability to aquatic organisms, and the existing conditions of the receiving waters.

Highway runoff may contain higher concentrations of metals, particularly: lead, zinc, iron, chromium, cadmium, nickel, and copper, that result from the ordinary wear of brakes, tires, and other vehicle parts. Although leaded gasoline was outlawed 25 years ago, lead is still being deposited on highway surfaces, (though in dramatically smaller quantities) through such sources as paints used on the right of ways and atmospheric deposition.

Heavy metals in highway runoff generally undergo physical, chemical, and biological transformations as they reach adjacent ecosystems. Sometimes, they are taken up by plants or animals, or adsorbed on clay particles. Other times. they settle to bottom sediments, or re-dissolve back into solution. Particulate fractions settling to the bottom surface of receiving waters may develop into sediments after several years of continuous deposition. These sediments may or may not leach metals depending on the condition and sensitivity of the receiving water. For example, chloride and acetate (from deicing chemicals) trigger the movement of metals that would otherwise remain in soil-ion exchange sites usually found in the first 20cm of the soil columns in sediments.

Concrete-lined drainage channel leading to a nearby drainage basin.

Concrete-lined drainage channel leading to a nearby drainage basin.

Various studies have revealed that low pH levels may also trigger metal solubility and leaching, especially when pH levels drop below 7.[14] However, this may not be the case in waters under different conditions. The potential leaching of copper, iron, chromium, and nickel, for example, is very limited or even unlikely to occur in natural waters where aerobic conditions are maintained.[15]

The form of a metal and its availability to organisms determine in great part the toxicity of water. Water with high total metal concentrations may indeed be less toxic than one having lower concentrations but *different forms* of the same metal. Ionic copper, for instance, is more harmful to aquatic organisms than organically bound or elemental copper.[16] Similarly, small concentrations of ionic zinc and cadmium are more readily available and toxic to aquatic life than large concentrations of their organic or non-ionic forms. Heavy metals in highway runoff are usually not a toxicity problem, but an analysis of each situation is prudent so that treatment is provided where appropriate.

How to Treat Highway Runoff

The adverse effect of highway runoff water quality can be minimized through structural or non-structural best management practices (BMPs) or through a combination of both. Structural BMPs operate by physically trapping runoff until contaminants settle out or are filtered through the underlying soils. The basic mechanisms for constituent removal are gravity settling, infiltration of soluble nutrients through soil or filters, or biological and chemical processes. Non-structural BMPs, on the other hand, are source control practices such as street sweeping, land use planning, vegetated buffer areas, and fertilizer application controls. They are used to reduce the initial concentration and accumulation of contaminants in runoff. Non-structural BMPs may reduce the need for costly structural controls. Structural BMPs can be thought of as largely corrective measures to address existing and anticipated water quality problems.[17]

'a one-size fits all approach could result in spending funds for unnecessary or inappropriate treatment'

To select the most appropriate BMP, it is recommended that one takes into account the expected amount of runoff, type and amount of contaminants, availability of land, and physical characteristics of the site. Some BMPs can operate effectively regardless of weather conditions while others can't. Structural BMPs are not always suitable for areas where land space is limited, as in urban settings, while non-structural BMPs can be implemented just about anywhere, even where space is a constraint.

Structural BMPs consist of infiltration technologies, detention, retention, and vegetated practices, filtering systems, and porous pavements. **Infiltration technologies** make use of the physical, chemical, and biological interactions between soil and water to filter out sediments and other contaminants from highway runoff. As the runoff percolates into the ground, contaminant particles are trapped within the soil, and the resulting "treated" runoff makes its way to the ground water. Infiltration trenches and basins are most effective in removing total suspended solids, bacteria, and metals from highway runoff.[17] They have the advantage of being located underground but the disadvantage of being limited to areas that have adequate soil types and ground water table characteristics. They have an effective life of 10 to 15 years and require sediment/debris removal on a periodic basis. Infiltration basins, on the other hand, can operate effectively from 5 to 10 years before requiring deep tilling.[18]

Detention and retention ponds, wet or dry, provide both water quantity and water quality control since they store runoff temporarily and settle or retain suspended solids and other runoff contaminants. Detention ponds are known to be highly effective in the removal of nutrients and heavy metals.[19] **Wetland and shallow marsh systems**, on the other hand, use the nutrient uptake of vegetation to enhance constituent removal. However, wetlands are not as effective as detention ponds in the removal of metal constituents from highway runoff.[20] Ponds and wetland/pond combinations are expensive, require annual maintenance, raise liability concern, but they do have an effective life of 20 to 50 years. They are recommended for places where sufficient land and *funding* are available.[18]

Vegetated swales and filter strips are recommended for sites with limited land space. These technologies are designed to catch and filter highway runoff and to enhance the biological uptake of its constituents. Vegetated swales incur moderate capital costs and their effective life span is 5 to 20 years. Filter strips, on the other hand, are low cost technologies with a much longer effective life (20 to 50 years). Filter strips can be installed easily along roadside corridors.[21]

Filtering systems are useful in sites with limited land space. Unlike infiltration technologies, filtering systems have no soil restrictions and, even though several designs have been developed, all of them consist of a sedimentation area to retain large particles and a filter chamber that filters and removes suspended constituents.

In contrast to conventional pavements, **Porous pavements** are unique in their design. Porous pavements allow storm water to percolate through the pavement and infiltrate into the soil underneath. In the form of asphalt, concrete, or interlocking paving stones, porous pavements allow light duty roads, sidewalks, parking lots, and other impervious surfaces to keep their natural infiltrating capacity while allowing for limited vehicle and pedestrian traffic. In order for porous pavements to function effectively, they must be sited, designed, and installed correctly, and, of course, they must be cleaned on a regular basis to prevent clogging.[22] Porous pavements can remove total suspended solids, total phosphorus, and total nitrogen effectively within a life span of 15 to 20 years.[23]

Summary

Highway runoff is generally not harmful. The Federal Highway Administration encourages all jurisdictions to learn about highway runoff and its properties before implementing any strategies for its control. Given that no runoff waters are the same, a one-size-fits all approach could result in spending funds for unnecessary or inappropriate treatment. The following references will help one prepare a solution based on scientific facts and will guide one in the selection of a management practice that best suits the situation.

References

1. G, K. Young, S. Stein, P. Cole, T. Kammer, F. Graziano, and F. Bank, 1996. Evaluation and Management of Highway Runoff Water Quality. U.S. Department of Transportation, Federal Highway Administration, FHWA-PD-96-032, Washington, D.C.
2. Smoot, J.L., Cox, C.D., and Turpin, A.M., 1997. Laboratory Testing of a System to Treat Highway Stormwater in Karst Areas. *The Engineering Geology and Hydrogeology of Karst Terranes*. Balkema, Rotterdam: Beck & Stephenson.
3. From the U.S. Environmental Protection Agency's web site www.ctcnet.net/scrip/amd.htm.
4. "Constituents of Highway Runoff." FHWA/RD-81/042. Federal Highway Administration, Washington, D.C., 1981.
5. From SCRIP's web site http://www.fhwa.dot.gov/exit.cfm?link=http://www.ctcnet.net/scrip/amd.htm as published on October 1, 1997.
6. "Ultra-Urban Best Management Practices." FHWA-PD-xx-xxx Draft. Federal Highway Administration, Washington, D.C., 1997.
7. G, K. Young, S. Stein, P. Cole, T. Kammer, F. Graziano, and F. Bank, 1996. *Evaluation and Management of Highway Runoff Water Quality*. U.S. Department of Transportation, Federal Highway Administration, FHWA-PD-96-032, Washington, D.C.
8. Smoot, J.L., Cox, C.D., and Turpin, A.M., 1997. Laboratory Testing of a System to Treat Highway Stormwater in Karst Areas. *The Engineering Geology and Hydrogeology of Karst Terranes*. Balkema, Rotterdam: Beck & Stephenson.
9. NCHRP Project 25-9 on "The Environmental Impact of Construction and Repair Materials on Surface and Ground Waters" is being conducted by Oregon State University, Department of Civil Engineering. The materials being examined are coal ash, foundry sands, rubber tire, municipal solid waste ash, phosphogypsum, recycled asphalt, recycled concrete, mine tailings, blast furnace slag, steel slag, roofing shingle scrap, and non-ferrous slag.
10. Scrap rubber is being tested in Virginia, municipal solid waste in New Hampshire, and coal ash in Indiana.
11. Jones, A.L., and Sroka, B.N., 1997. *Effects of Highway Deicing Chemicals on Shallow Unconsolidated Aquifiers in Ohio, Interim Report, 1988-93*. Water-Resources Investigations Report 97-4027, U.S. Geological Survey, Columbus, Ohio.
12. Walker, W. H. and Wood, F. O., 1973. *Road Salt Use and The Environment*. Highway Research Record No. 425, Highway Research Board, Washington, D.C.
13. The most widely used chemicals in snow and ice control are sodium Chloride (NaCl), Calcium Chloride (CaCl2), Magnesium Chloride (MgCl2), Calcium Magnesium Acetate (CMA) and Potassium Acetate (KAc).
14. Hanes, R.E., Zelazny, L.W., and Blaster, R.E., 1970. *Effects of Deicing Salts on Water Quality and Biota*. National Cooperative Highway Research Program No. 91, Highway Research Board, Washington, D.C.
15. Granato, G.E., Church P.E, and Stone, V.J., 1995. *Mobilization of Major and Trace Constituents of Highway Runoff in Groundwater Potentially Caused by Deicing Chemical Migration*. Highway Research Record No. 1483, Highway Research Board, Washington, D.C.
16. Y.A. Yousef, H.H. Harper, L.P. Wiseman, and J.M. Bateman, 1985. *Consequential Species of Heavy Metals in Highway Runoff*. Transportation Research Record No.1017, Transportation Research Board, Washington, D.C.
17. Young, G.K., Stein, P.C., Kammer, F.G., and Bank, F., 1996. *Evaluation and Management of Highway Runoff Water Quality*. Office of Environment and Planning, Federal Highway Administration, Washington, D.C.
18. "Ultra-Urban Best Management Practices." FHWA-PD-xx-xxx Draft. Federal Highway Administration, Washington, D.C., 1997.
19. Y.A. Yousef, H.H. Harper, L.P. Wiseman, and J.M. Bateman, 1985. *Consequential Species of Heavy Metals in Highway Runoff*. Transportation Research Record No.1017, Transportation Research Board, Washington, D.C.
20. USEPA, 1993. *Guidance Specifying Management Measures For Sources of Nonpoint Pollution in Coastal Waters*. United States Environmental Protection Agency, Office of Water, Washington, D.C.
21. Yu, S.L., Kaighn, R.J., Liao, S. and O'Flaherty, C. E., 1995. *The Control of Pollution in Highway Runoff Through Biofiltration*.
22. "Ultra-Urban Best Management Practices." FHWA-PD-xx-xxx Draft. Federal Highway Administration, Washington, D.C., 1997.
23. Young, G.K., Stein, P.C., Kammer, F.G., and Bank, F., 1996. *Evaluation and Management of Highway Runoff Water Quality*. Office of Environment and Planning, Federal Highway Administration, Washington, D.C.

FHWA Contacts:
Howard Jongedyk, HRDI
(202) 493-3077
Fred Bank, HENE
(202) 366-5004

Scheduled Update: Archive - No Update
Technical Issues: TFHRC.WebMaster@dot.gov

TRT Terms: Runoff; Water pollution; Water quality management

Updated: 03/08/2016

Appendix 7

Pathogen and chemical transport in the karst limestone of the Biscayne aquifer: 1. Revised conceptualization of groundwater flow

Robert A. Renken,[1] Kevin J. Cunningham,[1] Allen M. Shapiro,[2] Ronald W. Harvey,[3] Michael R. Zygnerski,[1] David W. Metge,[3] and Michael A. Wacker[1]

Received 23 March 2007; revised 17 May 2008; accepted 28 May 2008; published 23 August 2008.

[1] The Biscayne aquifer is a highly transmissive karst limestone that serves as the sole source of drinking water to over two million residents in south Florida. The aquifer is characterized by eogenetic karst, where the most transmissive void space can be an interconnected, touching-vug, biogenically influenced porosity of biogenic origin. Public supply wells in the aquifer are in close proximity to lakes established by surface mining. The mining of the limestone has occurred to the same depths as the production wells, which has raised concerns about pathogen and chemical transport from these surface water bodies. Hydraulic and forced gradient tracer tests were conducted to augment geologic and geophysical studies and to develop a hydrogeologic conceptual model of groundwater flow and chemical transport in the Biscayne aquifer. Geologic and geophysical data indicate multiple, areally extensive subhorizontal preferential flow zones of vuggy limestone separated by rock with a matrix pore system. The hydraulic response from an aquifer test suggests that the Biscayne aquifer behaves as a dual-porosity medium; however, the results of the tracer test showed rapid transport similar to other types of karst. The tracer test and concurrent temperature logging revealed that only one of the touching-vug flow zones dominates transport near the production wells. On the basis of the rising limb of the breakthrough curve, the dispersivity is estimated to be less than 3% of the tracer travel distance, which suggests that the fastest flow paths in the formation are likely to yield limited dilution of chemical constituents.

Citation: Renken, R. A., K. J. Cunningham, A. M. Shapiro, R. W. Harvey, M. R. Zygnerski, D. W. Metge, and M. A. Wacker (2008), Pathogen and chemical transport in the karst limestone of the Biscayne aquifer: 1. Revised conceptualization of groundwater flow, *Water Resour. Res.*, *44*, W08429, doi:10.1029/2007WR006058.

1. Introduction

[2] In 2000, more than 226 m^3/s of groundwater were withdrawn from carbonate aquifers for domestic use in the United States [*Maupin and Barber*, 2005]. Consequently, there is great interest in understanding the physical and biogeochemical processes affecting groundwater quality in carbonate aquifers, particularly in carbonate formations that have undergone karstification. Karst aquifers are typically viewed as excellent municipal sources of groundwater because they contain highly permeable solution-enlarged pore space from which to extract water. Problems of contamination and waterborne pathogens associated with domestic water supplies withdrawn from karst aquifers have been well documented [*Aley*, 1984], some of which have resulted in disease epidemics [*Pokrajčić*, 1976; *Worthington et al.*, 2002]. Source water protection in karst aquifers, however, is difficult to achieve because of the potential for rapid movement of solutes in solution-enlarged zones and limited attenuation of pollutants.

[3] Simulation of groundwater flow, coupled with advective particle transport has become a standard quantitative method to define regulatory wellhead protection. The placement of wellhead protection boundaries based on groundwater flow simulations, however, rarely incorporates the complex aquifer heterogeneity associated with karst aquifers. Numerical simulations of groundwater flow in karst aquifers conducted at a scale suitable for defining the capture area of a production well will usually employ bulk hydraulic properties of the formation (e.g., S. Painter et al., Edwards aquifer parameter estimation project final report, 2002, Southwest Research Institute, available at http://www.edwardsaquifer.org/pages/research_optimization.htm). Bulk hydraulic properties are appropriate in defining a general water budget over the modeled area to reproduce measured sources and sinks of groundwater and hydraulic gradients, but they cannot accurately identify the local resolution for estimating flow direction, flow rate, or a point source of contamination [*Worthington et al.*, 2002; *Scanlon et al.*, 2003].

[4] This paper and two companion articles [*Shapiro et al.*, 2008; *Harvey et al.*, 2008] discuss the potential for the transport of dissolved chemical constituents and waterborne

[1]Florida Integrated Science Center, U.S. Geological Survey, Fort Lauderdale, Florida, USA.
[2]U.S. Geological Survey, Reston, Virginia, USA.
[3]U.S. Geological Survey, Boulder, Colorado, USA.

Appendix 8

M E M O R A N D U M **(R-066-2014)**

TO: **David Martin, PE**
Project Management Coordinator
Division of Highway Design

FROM: **Bart Asher, PE, PLS**
Geotechnical Branch Manager
Division of Structural Design

BY: **Erik Scott, PE**
Geotechnical Branch

DATE: **January 26, 2016**

SUBJECT: **Hardin County**
FD04 047 3005 000-000 D
KY 3005
Ring Rd. Extension: Western KY Pkwy to I-65
Mainline Sta 305+41.16 to 414+03.00
Item No. 4-198.00
Mars No. 8666301D
Geotechnical Engineering Roadway Report

An abbreviated geotechnical engineering report has been completed for the subject project. The drilling and sampling for the project was performed by Stantec Consulting Services, Inc. under statewide drilling contract. Laboratory soil testing was also performed by Stantec under their statewide engineering and laboratory testing contract. The purpose of this investigation was to define soil the subsurface conditions for the project area. This project involves the extension of KY-3005 (Ring Road) from the Western Kentucky Parkway to I-65 in Hardin County, KY. Sufficient information to begin geotechnical work for the structures was not available as of the date of this report. Reduced size geotechnical symbol, geotechnical notes, soil profile, cut and embankment stability sheets are attached. The CADD input for these sheets, in DGN format, is being e-mailed to the Designer, QK4, Inc., for incorporation into the roadway plans.

The project is located within the Cecilia (No. 263) and Elizabethtown (No. 559) Geologic Quadrangles. The bedrock encountered is of the Ste. Genevieve Limestone Formation of the Mississippian Age (Upper Mississippian Series). Bedrock was only encountered in one boring, which revealed white to light gray, fine-grained limestone. A Select Rock Quantities Sheet (TC 66-208) was not required for this project. Based on the Rock Slope Design, some rock excavation is expected, mostly within cut limits from Stations 308+50 to 315+50. Insufficient rock quantities will be available for a rock roadbed. However available limestone from Roadway Excavation should be stockpiled for possible stabilization needs during construction.

The roadway drilling operations consisted of 60 disturbed soil borings, 73 rockline soundings for cut slope design, 34 rockline soundings for sinkholes, 13 rock core borings (accompanied by 12 cut stability borings), and 18 embankment stability borings. Five originally proposed borings were not drilled due to access being denied by the property owner. These included one rock core (Boring No. 6), two rockline soundings (No. 42, 43), and two disturbed soil borings (No. 115 and 116). Sufficient information was available to complete the investigation without these borings.

The soil testing showed the most common soil types for the project to be high and low plasticity clays (CH and CL in the Unified Soil Classification System), each with approximately 35% of the total samples. However, high plasticity clays are expected to be more commonly encountered in roadway excavation since the many of the low plasticity clays, silts, and sands were encountered in fill areas. The next most common soil was silty sand (SM), accounting for 12% of the soil samples. It should be noted that some of the soils exhibited high silt contents and are potentially moisture sensitive. In addition, the soil testing indicated that the natural moisture contents exceeded the optimum moisture contents in some areas of the project.

Subgrade problems may occur in areas where the existing pavement will be removed or where soft soils are present and the roadway template is in a shallow fill or cut condition. Therefore, a chemically stabilized of the subgrade is recommended for the project. Based on the available soil testing, lime appears to be the appropriate chemical for treating the majority of the project area. However, one area with silty or clayey sands at subgrade may be better suited for cement. This is from approximate stations 328+50 to 345+50. The decision on how to handle any silty areas will be left to the Engineer and Stabilization Contractor during construction. A 12-inch lime stabilized layer can be used throughout the project for quantity calculations. A 1-foot working platform consisting of KY Coarse Aggregate will be required for areas where chemical stabilization is not feasible such as cross-overs, tie-ins, entrances, etc. For the purpose of calculating quantities, assume **400 linear feet of roadway** for this treatment.

The wet/saturated conditions and poor soils mentioned above could also create problems during embankment construction. The extent of these problems will depend on the season of construction and seasonal water table fluctuations. The recommendations below provide for the use of Kentucky Coarse Aggregate No. 2, 3 or 23 and/or limestone from the project and Type IV Geotextile Fabric for stabilization of any such wet areas. **For quantity estimation purposes only for KY Coarse Aggregate and geotextile fabric,** a 2-foot embankment working platform wrapped with geotextile fabric may be assumed for **700 linear feet of roadway**, using an **average embankment width of 150 feet**.

Cut stability analyses of overburden soils were performed at critical cut sections throughout the alignment. The results of these analyses are shown on the attached cut stability sheets. The analyses indicated that soil cut slopes will need to be flatter than 2H:1V to attain an acceptable factor of safety for eight of the cut limits. These areas are listed in Geotechnical Recommendation No. 12 below.

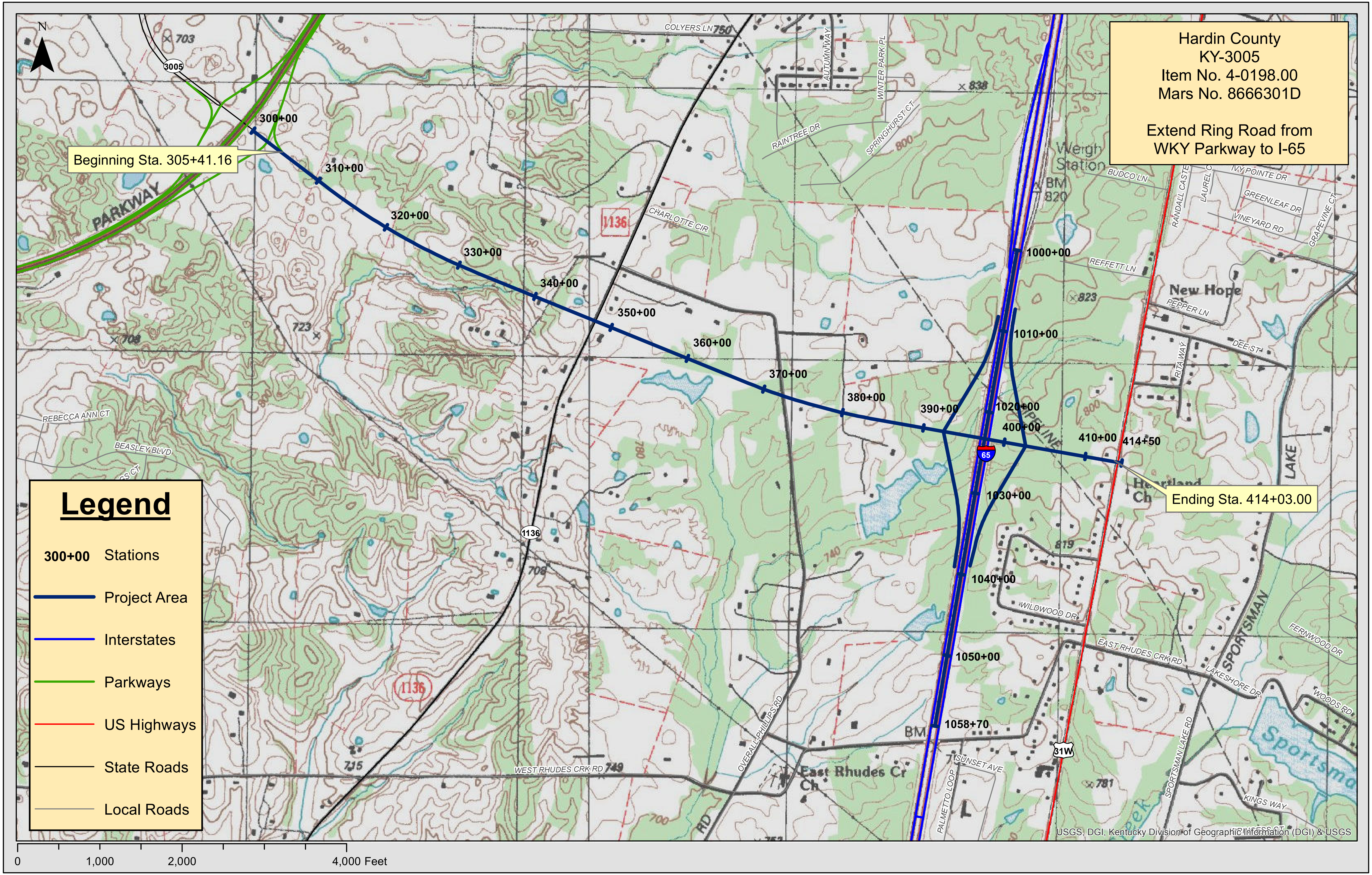
Embankment slope stability analyses were performed for critical sections throughout the alignment. The following table summarizes the embankment slope recommendations and provides the steepest allowable slopes. Slopes may be constructed flatter than these maximum allowable slopes. Rock replacement is required within the intervals below, to the specified distances below roadway grade, in order to achieve the required safety factors at the indicated slopes. Sufficient rock for this treatment is not available from the project and Coarse Aggregate from a quarry will be required. The inner portions of the embankments will be constructed with soil to reduce the quantities of quarried rock required. Geotextile Fabric will be required at all soil/rock interfaces to prevent migration of fines into the granular material. See the attached embankment stability sheets for results of the stability analyses and the required rock configurations.

The embankments at structures require a higher factor of safety for stability. Therefore, for embankment limits from 386+50 to the Bridge over I-65, greater rock embankment heights are required near the bridge, from Station 394+75 to the Toe of End Bent No. 1 Spill-thru.

Embankment Slope Recommendations

Critical Section	Approx. Embankment Limits	Max. Height of Embankment	Max. Steepness	Road Grade to Top of Aggregate
Mainline 333+00	332+00 to 340+50	26 ft.	2H:1V	N.A.
Mainline 389+00	386+50 to 394+75	64 ft.	2.5H:1V	43 ft.
Mainline 395+00	394+75 to Toe of End Bent #1 Spill-through Slope	64 ft.	2.5H:1V	34 ft.
Mainline 400+00	Toe of End Bent #2 Spill-through Slope to 412+50	45 ft.	2.5H:1V	N.A.
Ramp 1, 103+00	Ramp 1, 100+00 to 107+75	52 ft.	2.5H:1V	44 ft.
Ramp 1, 116+50	Ramp 1, 113+00 to 116+66	23 ft.	2H:1V	N.A.
Ramp 2, 214+50	Ramp 2, 213+25 to 216+57	25 ft.	2H:1V	N.A.
Ramp 3, 307+00	Ramp 3, 304+00 to 309+25	32 ft.	2H:1V	N.A.
Ramp 4, 414+50	Ramp 4, 407+50 to 416+20	40 ft.	2H:1V	30 ft.

Several sinkholes/basins have been identified on this project. Three sinkholes/basins will be receiving roadway drainage. Treatment for these sinkholes is outlined in Geotechnical Recommendations No. 16 and 17. The appropriate design procedures for sinkholes receiving drainage are to be detailed in the plans in accordance with the recommendations given below. Sinkholes within disturbed limits that are not receiving roadway drainage shall be filled/capped in accordance with Section 215 of the Standard Specifications, and the Sepia Drawing "Treatment of Open Sinkholes". These sinkholes are identified in Geotechnical Recommendation No. 15 below.


Hardin County
KY-3005
Item No. 4-0198.00
Mars No. 8666301D
Extend Ring Road from
WKY Parkway to I-65
Legend
300+00 Stations
Project Area
Interstates
Parkways
US Highways
State Roads
Local Roads
Beginning Sta. 305+41.16
Ending Sta. 414+03.00
300+00
310+00
320+00
330+00
340+00
350+00
360+00
370+00
380+00
390+00
400+00
410+00
414+50
1000+00
1010+00
1020+00
1030+00
1040+00
1050+00
1058+70
PARKWAY
COLYERS LN
AUTUMN WAY
WINTER PARK PL
RAINTREE DR
SPRINGHURST CT
CHARLOTTE CIR
BUDCO LN
IVY POINTE DR
GREENLEAF DR
VINEYARD RD
GRAPEVINE CT
REFFETT LN
New Hope
PEPPER LN
DEE ST
RITA WAY
REBECCA ANN CT
BEASLEY BLVD
Heartland Ch
WILDWOOD DR
EAST RHUDES CRK RD
LAKESHORE DR
FERNWOOD DR
WOODS RD
SPORTSMAN
LAKE
SPORTSMAN LAKE RD
KINGS WAY
SUNSET AVE
PALMETTO LOOP
East Rhudes Cr Ch
OVERALL PHILLIPS RD
WEST RHUDES CRK RD
Weigh Station
BM 820
3005
1136
65
31W
0
1,000
2,000
4,000 Feet
USGS, DGI, Kentucky Division of Geographic Information (DGI) & USGS

Appendix 9

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

OCT 28 2010

REPLY TO THE ATTENTION OF:

E-19J

Robert F. Tally, Jr., Division Administrator
Federal Highway Administration - Indiana Division
575 North Pennsylvania St., Room 254
Indianapolis, IN 46204

Michael B. Cline, Commissioner
Indiana Department of Transportation
100 North Senate Ave., Room N642
Indianapolis, Indiana 46204

RE: I-69 Evansville to Indianapolis, Tier 2 Draft Environmental Impact Statement (DEIS) for Section 4: Crane NSWC to Bloomington, Indiana. CEQ No. 20100281

Dear Mr. Tally and Mr. Cline:

The U.S. Environmental Protection Agency Region 5 (EPA) reviewed the Federal Highway Administration (FHWA)/Indiana Department of Transportation (INDOT) I-69 Tier 2 Section 4 Draft Environmental Impact Statement (DEIS), pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA), and Section 309 of the Clean Air Act. The Section 4 Tier 2 DEIS is the fourth of six Tier 2 DEISs EPA reviewed for the 142-mile-long I-69 Indianapolis to Evansville Project. Section 4 extends approximately 22 miles from just east of US 231 to State Road 37 (SR 37).

The DEIS-identified Preferred Alternative is Alternative 2, comprised of subsection alignments 4A-2, 4B-1, 4C-2, 4D-1, Hybrid 4E-1/4E-2, 4F-3, 4G-2 and 4H-2, with three proposed interchanges (Option 1) at SR 45, Greene/Monroe County Line (with the South Connector Road Option) and SR 37. The Greene/Monroe County Line interchange with an approximately 1-mile long connector road to SR 45/SR 445 was introduced as a potential new interchange location for Section 4 after the Tier 1 FEIS/Record of Decision (ROD).

EPA rates the DEIS preferred alternative as "EC-2, Environmental Concerns-Insufficient Information." In order to fully assess environmental impacts, additional analysis regarding the vulnerability of water resources should be undertaken. In order to fully protect the environment, additional mitigation measures should be identified in the Final EIS (FEIS). An explanation of our rating system can be found in the enclosure entitled, "Summary of Rating Definitions and Follow-Up Actions." Our detailed

This is a much more extensive quantity of stream mitigation than the calculations by acres assumed in the DEIS. Stream mitigation needs to maximize preserving and restoring the existing natural drainage network. It should not rely on simply inserting "naturally-structured" channels with reduced catchment size in new locations. Projects are substantially more effective when both banks of the stream can be protected through riparian corridors. Unfortunately, land parcel boundaries are often drawn up with a stream as a boundary.
Recommendation: When assembling parcels for mitigation sites from the known array of prospective sites with interested cooperating owners, we recommend additional inquiries be conducted to see if the landowners on any excluded opposite stream bank are willing to consider a riparian corridor easement. Including the opposite bank would add to the quality, quantity, long-term effectiveness, and stability of the stream restoration or enhancement project.

As mitigation plans are made, suitable wetland and stream mitigation performance standards will need to be developed, incorporating both physical and biological standards.

Conservation Easements: The DEIS identifies that INDOT intends to purchase mitigation easements to protect mitigation sites in perpetuity. The mitigation lands will be turned over to an appropriate government conservation and management agency; will contain deed restrictions identifying them as mitigation sites and protecting them from further disturbance; will be planted with mixture of native trees largely composed of species having high value as potential Indiana bat roost trees; will include buffer areas around Indiana bat hibernacula; and will include obtaining easement for other protection measures for Indiana bat hibernacula. (DEIS pp. 7-4 through 7-6, 7-26, and 7-37 through 7-39.) (INDOT Answer #14)
Recommendation: We recommend the FEIS clarify whether INDOT will provide sufficient funds to the government conservation and management agency to support maintenance of the sites in perpetuity and the education of current and future landowners about the mitigation projects and about being good land and water stewards. In addition the FEIS should identify whether there will be a way to enforce or correct any misplaced actions/inactions by the easement-granting landowners that may adversely impact the integrity of the mitigation site. The easement agreements should be clear about whose job it will be to enforce the terms of the easements. (Response #14)

KARST RESOURCES

Recommendation: EPA recommends the FEIS address the following karst impact issues identified in the I-69 Section 4 DEIS:

<u>Analysis of Karst Impacts as part of the Alternatives Consideration Process</u>
We have concerns that the appropriate level of consideration was not given to the various karst feature types presented in the DEIS. As such, the alternatives analysis completed for Section 4 Corridor appears to have considered impacts to the seventeen different karst feature types as equals. With respect to karst resources, in order to adequately assess alternative impacts, consideration must be given to karst feature size, location, infiltration rate, recharge/discharge characteristics, connectivity to

groundwater conveyances, potential T&E species impacts, potential water quality impacts, threats to the traveling public, etc. For example, impacts to a sinking stream should not be weighed equally to impacts associated with a low-infiltration sinkhole. The fact that an alternative impacts a lower number of karst features does not necessarily guarantee that it will result in the least amount of environmental impacts. Assigning weights to each karst feature type based on their quality, connectedness, and sensitivity will ensure that the karst impacts associated with each alternative are adequately assessed.

Potential Impacts to Unknown Subsurface Karst Features
The DEIS acknowledges that the methodology developed for the karst survey included only those karst features that could be visually observed (i.e. surface features). The DEIS states that direct impacts to caves were avoided during alternative development and thus no direct impacts to known cave habitats and/or cave biota are anticipated. At the same time, the DEIS acknowledges that unidentified subterranean karst features are present and an unknown number of those features will be encountered during highway construction. How can a determination of no direct impacts to cave habitat or cave biota be made given the acknowledged lack of information related to subsurface karst features, specifically their size and location? The lack of subsurface karst feature data poses a severe threat to karst environments during construction of the proposed highway facility. The importance of identifying subsurface karst features early in the design phase is important as the exposure of subsurface karst complexes and the severance of groundwater conveyances can have negative consequences, particularly to karst fauna and flora and the quantity and quality of private/residential water supply features.

Potential Impacts on Drinking Water Quantity and Quality
The DEIS identified numerous private groundwater wells within and adjacent to the Section 4 corridor. Furthermore, the DEIS indicates that in some cases karst springs are utilized as a private/residential water supply alternative. The proposed action could potentially result in changes in drainage patterns to and from karst features if construction were to eliminate recharge features, sever conduits, and reduce flows. The result could be a reduction in water availability for landowners who rely on said water supply features for residential or agricultural uses.

Karst recharge features act as direct conduits to groundwater conveyances and supplies. Stormwater runoff, both during and following construction of the proposed highway facility, is a serious threat to groundwater quality if appropriate pre-construction and post-construction BMPs are not identified, implemented, and maintained. Induced development resulting from construction of the proposed highway facility can also impact groundwater quality through the addition of septic systems and impervious surfaces within karst zones of susceptibility.

Karst Fauna Study Methodology
The Section 4 cave inventory effort identified 63 caves within the study area, including 14 caves with entrances located within the Section 4 corridor. As noted in Section 4 Survey of Karst Features Report, 6 caves "within and in proximity" to the Section 4 Corridor were sampled to determine the presence of invertebrates. These sites were

EPA would like to see a comparative analysis of low flow (average rainfall event) conditions versus a high flow conditions (extreme rainfall event). Evaluating varying flow conditions is key component of pollutant loading studies as the volume of water represents the denominator of the calculation and thus has an impact on loading concentrations. If a pollutant load remains constant throughout the study, a higher volume of water will essentially dilute the concentration and thus the results will fall below regulatory criteria. Providing a comparative analysis of high flow versus low flow conditions would provide results which better represent natural conditions.

6.0 Potential Measures to Minimize Impacts to Karst

6.4 Operation and Maintenance

[Page 70]
Is void filling an "appropriate and practicable" mitigation strategy? Void filling will isolate the underground opening on either side of the fill. Animal migration, water flow, and air flow would be drastically impacted. The damming effect could redirect the water into other ecosystems that are currently dry or cause a blow out on the ground surface or beneath an embankment section. In addition, introducing cementateous products into the voids would impact the temperature due to the heat of hydration, which could have a negative impact on the fauna.

Did the report examine the use of geogrid or geotextile layers in the lower reaches of construction embankment or roadway subgrades? This practice has been shown to be effective in mitigating piping/collapse of embankment over karst terrains.

The report states - *"Examination of the areas that receive runoff from the highway to detect soil piping or opening of buried karst features."* What is the recommended frequency of these inspections? Who is qualified to perform them? Whose responsibility is it to perform them?

The report states - *"Improved technology should be used to update, maintain, and alter any treatment and containment structures when deemed necessary."* What does this statement mean? Are there some pending technologies that may be applicable? If so, a discussion should be added.

The report mentions elsewhere that minimal salt use will be a strategy used for minimizing roadway pollution. This strategy should be included in this list as well.

7.0 Summary and Conclusions

[Page 107]
The report states - *"Therefore, the focus of alignment selection and design should be on minimizing the impacts on the karst system, and any biological communities within them, by avoiding critical features…."*. What defines a critical feature? It would be helpful to provide a listing of the critical features considered as part of the alignment evaluation process.

Appendix 10

IRC. 968

U.S. GEOLOGICAL SURVEY CIRCULAR 968

Development of Sinkholes Resulting From Man's Activities in the Eastern United States

another site with less risk or using engineering practices that will eliminate or minimize the problem. Most of these alternatives or precautions involve foundation design, surface-runoff management, and impoundment-engineering practices such as compaction and lining. Where a degree of risk cannot be assigned, the land user's most protective measure is the minimizing of landform and drainage alterations.

SUMMARY AND CONCLUSIONS

1. Thousands of sinkholes have formed in the Eastern United States since 1950. Most of these were induced by man's activities changing the hydrologic environment. Collapses forming natural sinkholes are rare in many terranes.
2. Sinkhole development was identified in 19 of 31 States in the study area. More than 850 sites were inventoried; it is estimated that more than 6,500 sinkholes or related features have occurred at these sites. Extensive inventories are available only for Alabama and Missouri. The Alabama inventory, the most comprehensive, was used as a guide in this study.
3. Total cost of damage and associated protective measures is unknown. Costs reported during the limited inventory amounted to about $170 million, expended almost entirely after 1970. Of this, about $140 million was expended for protective measures at five dams or impoundments in Alabama, Georgia, Kentucky, and North Carolina, and to repair or protect highways in Alabama and Tennessee.
4. Available information shows that the impact of sinkholes has been most significant in Alabama, Florida, Georgia, Missouri, Pennsylvania, and Tennessee. States with the least impact are located in areas formerly covered by glaciers.
5. Loss of life resulting from sinkholes is rare. Fatalities resulting from or associated with sinkholes have been reported in Florida, Missouri, and Pennsylvania. Injuries have been reported in Alabama, Florida, and South Carolina.
6. The sudden development of sinkholes results from the collapse of the roof of a cavity or cavern in rock, or from the downward migration of unconsolidated deposits into solutionally enlarged openings in the top of bedrock. Cavities in unconsolidated deposits form when the deposits migrate downward into bedrock openings. The occurrence of roof collapse in bedrock, compared with that of roofs of cavities in unconsolidated deposits, is rare.
7. Mechanisms that initiate most natural and induced sinkholes are the same.
8. Most induced sinkholes related to water activities, if these activities had not stressed the system, either (1) would not have occurred, (2) would not have occurred during a man's lifetime, or (3) would, under natural conditions, have occurred as subsidence rather than collapse.
9. Induced sinkholes are separated into those resulting from a decline in water level and those resulting from construction. Construction includes erection of structures, grading, blasting, and any other activities that result in the alteration of the land surface and the diversion and impoundment of drainage. Diversion of drainage includes any activity that changes rates of recharge, such as the removal of timber and drilling, coring, and augering where pumpage is not involved. Diversion and impoundment of drainage account for most sinkholes resulting from construction.
10. Mechanisms that trigger induced sinkhole development resulting from a decline in water level are (1) loss of buoyant support, (2) increase in velocity of ground-water movement, (3) increase in magnitude of water-level fluctuations, and (4) movement of water from the land surface to openings in bedrock where recharge had previously been largely rejected.
11. Mechanisms that trigger induced sinkhole development resulting from construction include (1) loading, (2) saturation, (3) piping, and (4) shocks or vibrations. Sinkholes resulting from shocks and vibrations are rare.
12. Assessment of existing or potential sinkhole problems requires recognition of features associated with sinkhole development, site evaluation, and an understanding of triggering mechanisms.
13. Most site evaluations are made to assess an area for a particular land use, to identify sinkhole development, to evaluate potential for additional sinkhole occurrence, or to

assess damage and the need for repairs. Available information includes geologic maps and reports, topographic maps, aerial photographs, and water records. Field observation is made to acquire other data and to determine what additional information is needed. Additional information is commonly acquired by drilling and pumping, augering, and coring. Depending on need, information may also be obtained by airborne remote sensing, subsurface geophysical, and other techniques.

14. Where and when natural sinkholes will occur is not predictable. Induced sinkholes resulting from water activities are predictable in some instances, but only in the sense that they will occur within a particular area. This predictability is restricted to certain terranes and is dependent on the degree and type of impact to be exerted. Prediction is enhanced by site evaluation and case histories. The most predictable induced development is that resulting from dewatering by wells, quarries, and mines.
15. Alternatives that allow avoiding or minimizing sinkhole hazards are most numerous when a problem or potential problem is recognized during site evaluation. The number of available alternatives declines after site development begins.
16. Where sinkhole development is predictable, zoning of land use can minimize hazards.

SELECTED REFERENCES

Aley, T.J., Williams, J.H., and Massello, J.W., 1972, Groundwater contamination and sinkhole collapse induced by leaky impoundments in soluble rock terrane: Missouri Geological Survey and Resources, Engineering Geology Series, no. 5, 32 p.

Allen, A.S., 1969, Geologic settings of subsidence, *in* Reviews in engineering geology: Geological Society of America, v. 2, p. 305–342.

Beck, B.F., 1984, Sinkhole terminology, *in* Beck, B.F., ed., Sinkholes: Their geology, engineering, and environmental impact: First Multidisciplinary Conference on Sinkholes, Orlando, Fla., 1984: Rotterdam/Boston, A. Balkema, 429 p.

Coleman, A.M., and Balchin, W.G.V., 1959, The origin and development of surface depression in the Mendip Hills: Geological Association of London, Proceedings, v. 70, pt. 4, p. 291–309.

Court of Appeals of Maryland, 1968, George M. Finley et ux. *v.* Teter Stone, Inc., no. 335 *in* 248 Atlantic Reporter: 2d ser., p. 106–117.

Davies, W.E., 1951, Mechanics of cavern breakdown: National Speleological Society Bulletin no. 13, p. 36–43.

Donaldson, G.W., 1963, Sinkholes and subsidence caused by subsurface erosion: Regional Conference for Africa on Soil Mechanics and Foundation Engineering, 3d, Salisbury, Southern Rhodesia, 1963, Proceedings, p. 123–125.

Foose, R.M., 1953, Ground-water behavior in the Hershey Valley, Pennsylvania: Geological Society of America Bulletin 64, p. 623–645.

______1967, Sinkhole formation by ground-water withdrawal, Far West Rand, South Africa: Science, v. 157, p. 1045–1048.

______1969, Mine dewatering and recharge in carbonate rocks near Hershey, Pennsylvania, *in* Legal aspects of geology in engineering practice: Geological Society of America, Engineering Geological Case Histories, no. 7, p. 45–60.

Goughnour, R.D., Anderson, Robert, and DiMaggio, Jerome, 1979, Limestone related problems on transportation facilities, *in* U.S. Department of Transportation, Highway Focus, v. 11, no. 2, p. 1–31.

Herrick, S.M., and LeGrand, H.E., 1964, Solution of subsidence of a limestone terrane in southwest Georgia: International Association of Scientific Hydrology Bulletin, v. 9, no. 2, p. 25–36.

Howard, A.D., 1963, The development of karst features: National Speleological Society Bulletin, v. 25, pt. 2, p. 45–65.

Jammal and Associates, 1982, The Winter Park sinkhole—A report to the City of Winter Park, Florida.

Jennings, J.E., 1966, Building on dolomites in the Transvaal: The Civil Engineer in South Africa, v. 8, no. 2, p. 41–62.

Jennings, J.E., Brink, A.B.A., Louw, A., and Gowan, G.D., 1965, Sinkholes and subsidence in the Transvaal dolomites of South Africa: International Conference on Soil Mechanics, 6th, Montreal, Canada, 1965, Proceedings, p. 51–54.

Johnston, W.D., Jr., 1933, Ground water in the Paleozoic rocks of northern Alabama: Alabama Geological Survey Special Report 16, 414 p.

Kemmerley, P.R., 1980, Sinkhole collapse in Montgomery County, Tennessee: Tennessee Division of Geology Environmental Geology Series, no. 6, 42 p.

Knight, F.J., 1970, Geologic problems of urban growth in limestone terranes of Pennsylvania: Association of Engineering Geologists Annual Meeting, Washington, D.C., 1970, Preprint, 16 p.

LeGrand, H.E., and Stringfield, V.T., 1971, Water levels in carbonate rock terranes: Ground Water, v. 9, no. 3, p. 4–10.

Miller, B.L., 1941, Allentown quadrangle: Pennsylvania Geological Survey Atlas 206, 492 p.

Moore, H.L., 1980, Karst problems along Tennessee highways, an overview: 31st Annual Highway Geology Symposium, Austin, Tex., Reprint, 68 p.

Newton, J.G., 1976a, Early detection and correction of sinkhole problems in Alabama, with preliminary evaluation of remote sensing applications: Alabama Highway Department, Bureau of Research and Development, Research Report HPR-76, 83 p.

______1976b, Induced sinkholes—A continuing problem along Alabama highways: International Association of Hydrological Sciences, Anaheim [Calif.] Symposium, 1976, Proceedings, no. 21, p. 453–463.

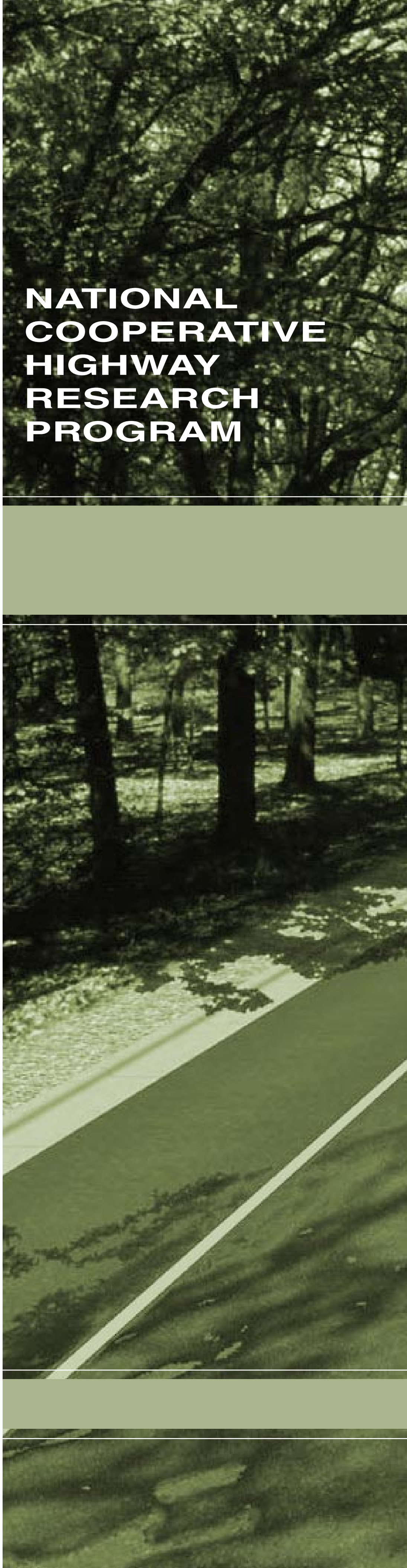
Newton, J.G., Copeland, C.W., and Scarbrough, L.W., 1973, Sinkhole problem along proposed route of Interstate 459 near Greenwood, Alabama: Alabama Geological Survey Circular 83, 53 p.

Newton, J.G., and Hyde, L.W., 1971, Sinkhole problem in and near Roberts Industrial Subdivision, Birmingham, Alabama—A reconnaissance: Alabama Geological Survey Circular 68, 42 p.

Appendix 11

NCHRP

REPORT 480



A Guide to Best Practices for Achieving Context Sensitive Solutions

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

E. ACHIEVING ENVIRONMENTAL SENSITIVITY

James Codell, Secretary of the Kentucky Transportation Cabinet, expresses the vision of Kentucky and provides direction to his staff who work on projects for Kentucky residents. *"You should act as if the project is going through your own back yard."* Achieving environmental sensitivity is much more than completing technical analyses or submitting mandated forms or documents. It is a commitment to, in the view of Federal Lands Division philosophy, assure that a project "lays lightly on the land." Context sensitive professionals and organizations see themselves as environmental stewards, not just transportation providers. This attitude and approach to their work represents a significant difference from the old way of doing business.

CSD_100E_1

MANAGEMENT STRUCTURE

CSD/CSS means involving social, economic, and environmental considerations as a meaningful part of the solutions generating process, not as add-ons or after-the-fact steps. In the remainder of this section, a reference to environmental considerations is assumed to mean the broad spectrum of SEE (social, economic, and environmental) effects. This CSD/CSS approach helps build consensus for the eventual decision and saves costs by incorporating such considerations from the beginning when it is easier to accommodate change. Environmental sensitivity means incorporating consideration of SEE effects within the alternatives development process. This is an advance over outdated agency processes in which engineers determine an alignment or plan, and then "after-the-fact" evaluate the plan for adverse environmental consequences. Exhibit E-1 (following page) shows a comparison of the old model versus the new model.

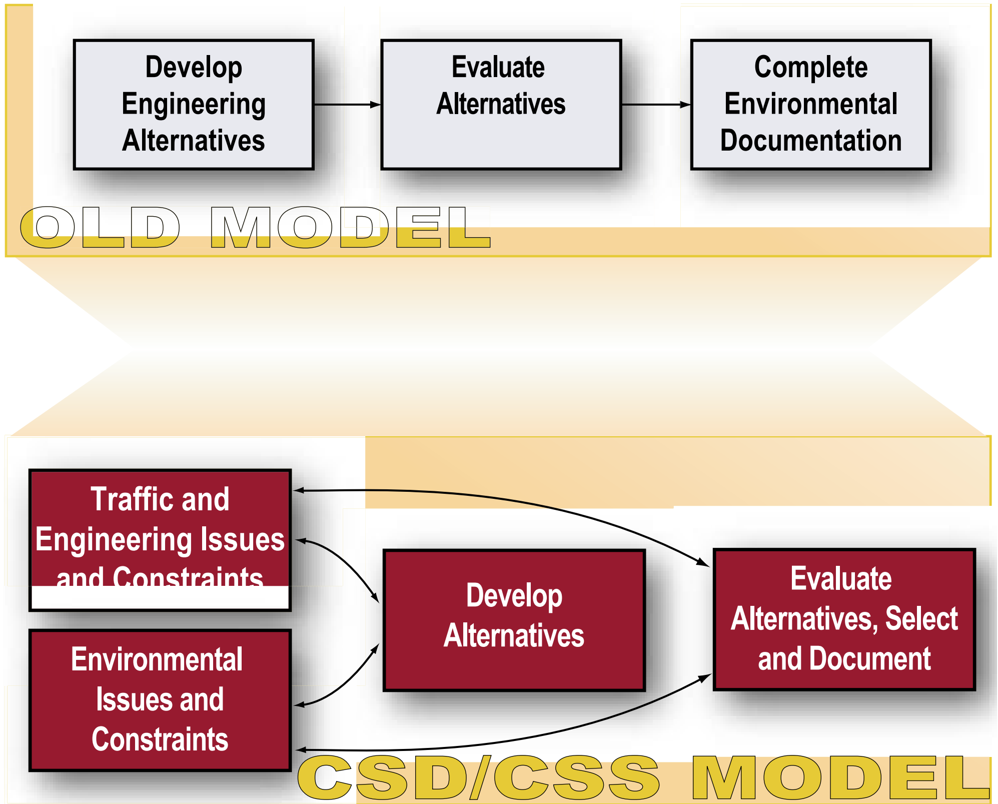
ESTABLISH ENVIRONMENTAL REVIEW PROCESS

Perhaps the key management issue is determining if the project will be conducted under NEPA. There may be confusion about the relationship of NEPA and CSD/CSS, but steps in the two processes are nearly identical, and the two can fit together very easily. The processes are overlayed and integrated, not run consecutively. Both aim at selecting the best alternative, both are intended to provide timely information for effective decision making, and both provide the interdisciplinary framework for considering the positive and negative impacts of the proposed action.

Because NEPA is a national law that applies to all federal agency actions, it is almost always implemented through a series of regulations promulgated by each federal agency and in many cases each state DOT. Despite this national law, and the common aim to provide the agency with a defensible decision process, each of these agency regulations is different from the others in its particulars. In all NEPA projects, though, it is necessary to identify the lead and cooperating agencies as well as the type of review required. It may not be possible to determine if an EIS, EA, or CE is appropriate during the first step of the process, although in many cases the lead agencies are able to make the decision even at this early point. The earlier the determination can be made, the better, because it affects the design of the public and agency outreach programs as well as a variety of data gathering efforts.

If the project does not require either federal funding, a federal agency permit, or other approval action, and is therefore not subject to NEPA regulations, the environmental review process will likely be guided by local, regional, or state environmental regulations as well as response to stakeholder issues and concerns. Some agencies choose to follow NEPA even if it is not required to ensure that if conditions change, and a federal action is later triggered by the project, there is no need for "back tracking" to accommodate federal requirements.

Exhibit E-1 *Context Sensitive Approach – Integrating Concurrent Engineering and Environmental Analysis*



CSD_118_3

In addition to understanding the relationship of the project to NEPA, it is also important to determine the applicability of other regulations that can affect the development, evaluation, and selection of alternatives, and the ultimate implementability of the project. Such regulations might include local, regional, or state laws that control land use; restrain urban growth; protect against adverse impacts to specific lands, species, or other resources; require a public vote to approve certain types of projects; or require a public vote to approve funding for particular projects.

Knowledge of the regulatory framework in which the project will be developed at the outset of project development helps to avoid surprises that cause delays and rework at later stages of the process. The NEPA process is clearly intended to operate as an umbrella approach so that all related environmental laws, regulations, and policies are considered in a coordinated fashion during decision making.

DEVELOP AGENCY OUTREACH PLAN

The "Reflecting Community Values" section of the report described the development of a public involvement plan (Section D). The development of a plan for involving resource, regulatory, and other agencies is similar, and is often included as part of the public involvement plan. Organizations typically consulted include federal transportation agencies (Federal Highway Administration, Federal Transit Administration); state DOTs; local transportation and land use agencies (cities, counties, MPOs); Native American tribal organizations; federal resource agencies (Environmental Protection Agency, U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Forest Service, U.S. Parks Department); and other state natural resource/environmental protection/land use agencies such as Departments of Natural Resources and State Historic Preservation Offices.

Like other stakeholders, resource and regulatory agency staff have particular perspectives and specific constraints relating to their availability for involvement in the project. In planning for the participation of federal resource agencies, for example, it is important to remember that their operating procedures often make it very difficult for staff to participate in activities not directly connected to an ongoing NEPA process or permit action. Moreover, in most regulatory agencies staff is often spread very thin and forced to prioritize among many important projects and concurrent activities. Limited availability of agency staff often requires scheduling of special activities for them at selected project milestones rather than assuming they can participate as regular members of broad-based project advisory groups that will meet often during the development process. Field trips, special resource agency advisory groups that meet only several times during project development, and focused resource agency workshops are proven effective approaches for achieving agency involvement.

Pilot states working with agency stakeholders have attempted to maintain an environmental stewardship focus and at the same time improve efficiencies. The Connecticut DOT is working with the FHWA Division Office and Connecticut State Historic Preservation Office (SHPO) to develop programmatic agreements covering minor projects and even minor work efforts on the Merritt Parkway, which is listed on the National Register of Historic Places. Other agreements involve continual coordination at every stage of an archaeological investigation. In Kentucky, as part of a section 106 Programmatic agreement, a consultation procedure is being established between the State and Native Americans, even though there are no federally recognized tribes in the state.

North Carolina DOT is acting as an environmental streamlining laboratory. The vision of NCDOT is to engage all stakeholders in a shared, efficient, and balanced process that advances environmental streamlining while maintaining environmental stewardship.

Despite budget and time constraints, it is critical to the success of the CSD/CSS (and NEPA) process to obtain information from the appropriate resource and regulatory agencies concerning problem definition, evaluation criteria, alternatives development, alternatives evaluation, and the identification of a preferred alternative.

PROVIDE STAFFING SUPPORT

Achieving environmental sensitivity and maintaining control over a project's schedule and budget requires commitment of resources at the project level. In Kentucky, the Transportation Cabinet created 12 staff positions to monitor all environmental activities at the District level. The Maryland SHA has undertaken similar action. Kentucky also has established an Environmental Advisory Team, consisting of KTC staff, FHWA staff, and consultants to track environmental commitments and look for opportunities to streamline and improve the process.

Agencies new to CSD/CSS may find it necessary to increase the level of staff support or retain consulting services for environmental coordination and project development activities.

PROBLEM DEFINITION

DEVELOP PROBLEM STATEMENT

An early step in both the CSD/CSS and NEPA processes is the identification of the problems to be solved and the development of a problem statement. It is critical that the statement be useful for development and evaluation of potential solutions. Problems must be stated in terms of underlying causes. For example, congestion, in itself, may not a problem, but rather a symptom of a problem. If, instead, the problem is defined as travel demand that exceeds capacity, the problem has been framed in a way that can lead to a solution—it is either possible to attack the problem from the demand side or the capacity side, or a combination of the two.

Similarly, problem statements should avoid being mode specific. Thus, for example, a problem is not the lack of light rail transit lines from point A to point B. Rather, there may be a lack of transportation options within a particular corridor where only auto transportation options exist. Solutions could include expanding opportunities for bike, pedestrian, light rail, bus, and other public transportation.

In some cases, a problem could relate to a particular type of vehicle. For example, roadway geometry that makes it difficult for emergency vehicles or particular types of trucks to gain access or to complete specific turning movements could be a significant problem in a corridor used heavily for freight movement.

Problem statements generally define the current conditions as well as conditions at the end of the forecast year, generally accepted as a 20-year planning period. Even though transportation performance may not be a problem now, future conditions may not meet local or state performance guidelines of a road segment or intersection. Projecting traffic demand 20 years in the future can be very controversial. Making sure there is agreement concerning the modeling assumptions involved in these projections is critical to the success of most urban projects because it goes directly to the heart of gaining agreement on the problems to be addressed.

While traditional problem statements focus on transportation performance issues, it is possible for them to also incorporate broader community issues such as economic development, visual identity, community character, and livability. In fact, this provides a much stronger problem statement and will more than likely help to differentiate among possible alternative solutions.

Staff from all pilot states are unanimous in their view that well thought-out, clearly communicated, and commonly understood problem statements go a long way to achieving both environmental sensitivity and project success.

CONDUCT SCOPING TO CONFIRM AND REFINE PROBLEM STATEMENT

Recreation and Natural Resource Enhancements Provided at Low Cost

With the replacement of the Flansburg/Nobleboro Bridges in Herkimer County, New York, the New York State DOT established a scenic West Canada Creek overlook, recreational crossings, and 1.5 acres of restored wetlands at minimal cost by including these features into project staging and excavation. External agency coordination was conducted with the Adirondack Park Agency; U.S. Fish and Wildlife Service, Environmental Protection Agency, and Park Service; the Town of Ohio; and the Ridge Runners Snowmobile Club.

The context of the proposed project is defined through *scoping*, a collaborative process with resource and regulatory agencies. This is one of the first opportunities to gather information about the environmental issues and constraints, about the natural and community resources that could be affected by the project. Scoping can also serve to help define the range of solutions or alternatives considered feasible. Most importantly, it provides agencies an opportunity to help separate issues of significance from those of less importance with the intent of being able to focus resources appropriately. It parallels the identification of issues and constraints described in Section D, Reflecting Community Values, in which public outreach is used to identify issues from a citizen perspective.

Scoping is an excellent opportunity to make sure that environmental considerations are not an after-thought in developing and evaluating alternatives, and to ensure that all of the relevant information is on the table early in the project so all of the trade-offs can be considered. This is the right time to gather ideas on what features could make the project better, more implementable, and more worthy of celebration. While scoping is often focused on discovery of natural resource issues and constraints, it is important to also incorporate examination of the social and economic (human environment) context as well.

If the project is being conducted under NEPA, scoping is required as part of the preparation of an EIS, and is often conducted during preparation of an EA. However, even if the project is not following a formal NEPA process, this collaborative data gathering activity is considered an essential part of the CSD/CSS process.

PROJECT DEVELOPMENT AND EVALUATION FRAMEWORK

INVOLVE STAKEHOLDERS IN FRAMEWORK DEVELOPMENT

Establishing criteria to be used in screening and evaluating project alternatives early in the process is absolutely critical to the defense of the eventual solution. Criteria can be derived from information gathered through the scoping process. Endorsement from the resource and regulatory agencies can then be sought prior to formal adoption of the evaluation framework. Some states, such as Pennsylvania, Oregon, and Washington, have processes in place to formalize agency review and endorsement of evaluation criteria, but informal review processes can be used to achieve alignment. Examples of evaluation criteria are included in Appendix D.

DEVELOP PURPOSE AND NEED

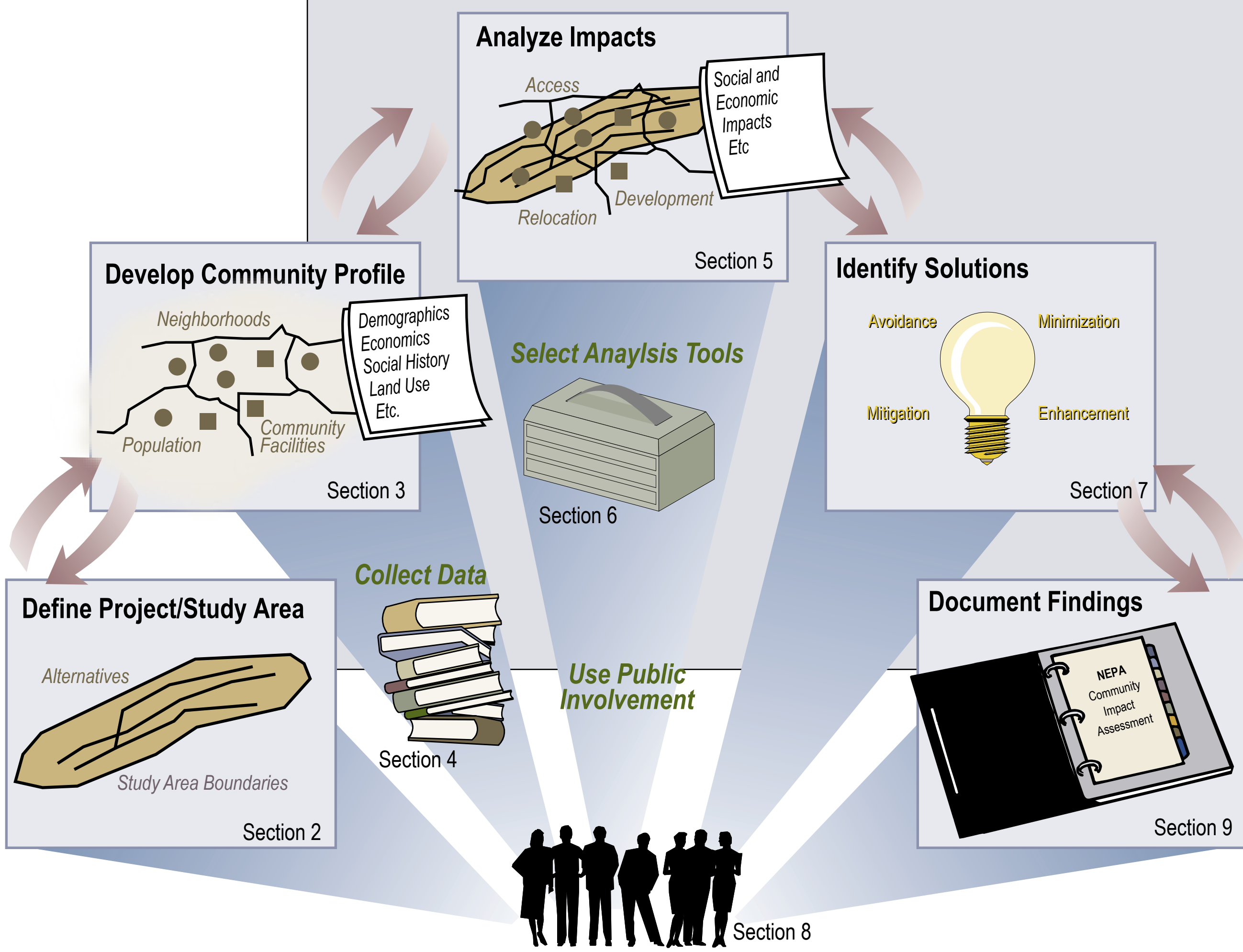
The Project Purpose and Need is a formal element of NEPA documentation. As such, it is technically not required for non-NEPA projects, but is strongly recommended because it firmly establishes the beginning framework for evaluating alternatives. The first question one must ask of any alternative is, "Does it meet the Purpose and Need?" The Purpose and Need must be derived from the problem statement, but it is limited to a discussion of transportation issues. It represents the reason the federal agency is contemplating taking action. While the USDOT may recognize the importance of achieving community livability, it is not authorized to invest in the transportation infrastructure solely for that reason.

Information provided in a Purpose and Need typically includes:

- Brief project history
- Transportation system linkage
- Capacity issues

In 1966, FHWA prepared a primer on Community Impact Assessment to address the impacts of proposed transportation actions on communities, neighborhoods, and people. The document suggests that when assessing community impacts, the analyst must be aware of the basic logic behind the process. The assessment diagram shown here provides the fundamental tasks in the process. The assessment process has the following components:

- Define the project and study area – Develop various project alternatives which satisfy the project purpose and need and identify potential impacts.
- Develop a community profile – Define the affected area, including neighborhood boundaries, locations of residences and businesses, economic and demographic data, history of the community, and land use plans.
- Analyze impacts – Assess the impacts to the community of the proposed action versus no action. Investigate consequences of the action.
- Identify solutions – Identify potential solutions to address adverse impacts.
- Use public involvement – Involve the public in developing project alternatives. This step is integral to all the above steps.
- Document findings – Provide oral presentations and a written report documenting findings for distribution to interested parties and support decisions.



Community Impact Assessment Process

CSD_121_2

- Transportation demand
- Legislative mandate
- Moral relationships
- Safety issues
- Rendering deficiencies

Preparation of the project Purpose and Need requires care because it, like the problem statement, must not imply a specific solution, but must be stated in terms of underlying causes. Yet, it cannot be so broad as to invite investigation of alternatives outside a reasonable spectrum of options. Again, asking that first question can help narrow the range of alternatives and facilitate spending resources on only examining reasonable potential solutions.

In many cases, a great deal of problem analysis may already have been completed as part of the agency's prior planning process. This prior planning work can provide data that can be used to narrow down the Purpose and Need. For example, the corridor in questions may have been evaluated and rejected as a new transit corridor, indicating it is only viable for Transportation System Management, Transportation Demand Management, auto, bicycle, and pedestrian modal solutions. Or, a regional planning study may have evaluated a number of bridge repair and replacement options, indicating that repair is not viable and that a new bridge must be built serving the existing corridor. It is important to take advantage of any previous work in developing a Purpose and Need statement.

ALTERNATIVES DEVELOPMENT

Wildlife Features Add Aesthetic Value

Wildlife plantings and nest boxes for kestrels and wood ducks enhance the aesthetics of the Lake Ontario State Parkway in Monroe and Orleans County, New York, while providing wildlife shelter and food. Habitat is managed by mowing and selective thinning. Volunteer groups maintain the annual nest boxes. Partners in New York DOT project included the Braddock Bay Raptor Research Center; the New York State Office of Parks, Recreation, and Historic Preservation; the Nature Conservancy; and the Boy Scouts of America.

ENGAGE STAKEHOLDERS IN ALTERNATIVE IDENTIFICATION

This is the most creative part of the project development process, in which sets of solutions are crafted in response to the problem statement and the evaluation criteria. Alternatives are generally developed through iterative processes, including public, agency, and project team input.

It is important that resource and regulatory agencies as well as the general public have a meaningful opportunity to contribute ideas for solutions to the defined problem, and that the range of alternatives considered reflects the full range of ideas expressed. Documenting alternatives suggested through outreach activities, even though many will be screened out in the next step of the process, adds to the credibility of the process. It should be straightforward to understand why the establishment of evaluation criteria early in the process provides an excellent framework for quickly narrowing the alternatives receiving full consideration.

IDENTIFY OPPORTUNITIES FOR REDUCING ADVERSE ENVIRONMENTAL IMPACTS

A key concept in both CSD/CSS and NEPA is the notion that consideration of approaches for reducing adverse environmental impacts is required in the course of developing alternatives. The first aim is to avoid impacts entirely. Avoidance not only is best environmentally, but is generally the least expensive option. One pilot state, the Minnesota DOT, illustrates the value of focusing agency resources on avoidance. Mn/DOT's investment in MnModel (see Appendix E) was intended to provide their staff with the means to avoid archaeological sites during highway route location studies throughout the state.

If avoidance is not possible or impractical, the second aim is to minimize adverse impacts to the extent possible. Then, and only then, is mitigation considered. In other words, providing brick facing on sound walls to improve their visual appearance is a mitigation measure—completely avoiding the need for sound walls, or greatly reducing the linear feet of needed sound walls are both preferable choices.

In recent years, the concept of environmental stewardship has increasingly gained acceptance. Environmental stewardship is the practice of not only protecting, but enhancing the environment as a routine part of project development. While quite different from the formal Transportation Enhancements Program and dedicated funding created under ISTEA and maintained under TEA-21, it takes the familiar "avoid, minimize, mitigate" approach one step further. Environmental stewardship aims to leave environmental conditions better than they were before the project and encourages consideration of activities that are modest, natural extensions of project activities. For example, adding a fish ladder to a culvert that is included in a project is an enhancement that requires a bit more investment but adds an important benefit. This approach builds credibility and trust between transportation and resource agency staff, and with the public. This broad concept of not only protecting, but enhancing the environment, is gaining acceptance and is commonly referred to as "environmental stewardship."

Many agencies, including a number of the pilot states, have formalized processes for enhancing projects. Examples of landscaping and aesthetic design guidance documents are provided in Appendix E.

The cultural attitudes of professional design staff can also play a significant role in achieving environmental sensitivity and minimizing adverse impacts. Skilled highway designers take pride in minimizing construction cost or maximizing operational effectiveness of a highway. Designers that are environmental stewards can be just as effective. For example, the Maryland Route 355 project (see Section H, Case Studies) includes a unique design solution that retained a prominent, beautiful oak tree as part of a project to widen from two to six lanes. The solution, which involved plan, profile, and special irrigation systems, was identified not by local or environmental stakeholders, but by highway design staff who were also environmental stewards.

Geographic Data Library Provides Information for Environmental Planning

The Florida Department of Transportation teamed with the Florida Department of Environmental Protection to fund the University of Florida GeoPlan Center's efforts to consolidate, house, and maintain Florida's publicly-funded GIS data in a digital "library" (FGDL). Data and images were gathered from numerous state and federal agencies, nonprofit organizations, and private agencies. The data was converted into uniform file formats and projections, subjected to quality control, documented, and organized into a series of CD-ROMs. The library provides uniform data, allowing professionals as well as less technically proficient people to use land use, roads, soils, hydrology, cultural features, habitat, aerial photography, and other data. Applications of the data are being used to plan Florida's Statewide Greenways System and for the Wetlands Rapid Assessment Procedure Application that assists in evaluating wetlands. A new application being developed is the Environmental Screening Analysis tools that will help screen projects with significant secondary and cumulative impacts early in the planning process.

ALTERNATIVES SCREENING, EVALUATION, AND SELECTION

TAILOR LEVEL OF ANALYSIS

The level of environmental analysis varies dramatically depending on the type of study and the nature of the decision being made. For example, an environmental analysis of a variety of transportation improvements in a 60-mile corridor will be conducted at a much more general level of analysis than the improvements to a specific interchange. In the first case, the analysis is generally made from existing secondary source information and policy-level issues; the second requires comparisons of specific project footprint impacts.

In all cases, it is critical to obtain agreement from participating agencies (and oftentimes from resource and regulatory agencies) about the appropriate level of detail for the environmental analysis. The CSD/CSS process is likely to increase the amount of up front data gathering needed. It requires careful thinking about the types of information needed to consider all of the issues raised by stakeholders and embodied in the evaluation framework. If the cost of data collection is too high to be acceptable, additional work with stakeholders may be needed to modify data requirements to a more reasonable level. Existing data can be used in place of original data development. Keep in mind that the early consideration of this information is always with the goal that more options exist early in the process before there is an over-commitment of resources.

Successful and efficient project development and delivery almost always requires synchronicity between the level of detail in the engineering and environmental analysis. Failure can be expected when the level of engineering greatly exceeds the level of environmental analysis or vice versa. For example, not having enough information about the affected environment while advancing a design concept can lead to the discovery of a deal-breaker late in the process and the need to go back and search for another alternative. Conversely, having adequate information about the surrounding environment, but failing to consider the feasibility of tying in an interchange to a freeway corridor can also lead to backing up and looking for another alternative. It is also critical that construction feasibility be kept in mind as attempts to avoid, minimize, or mitigate environmental issues are pursued.

ENGAGE STAKEHOLDERS IN ALTERNATIVE EVALUATION

As discussed in Section C, Effective Decision Making, and Section D, Reflecting Community Values, there are many effective ways for involving stakeholders in the alternatives screening, evaluation, and selection process. This alternatives evaluation is central to CSD/CSS and is also the heart of the NEPA process. It is the primary method of balancing impacts and benefits while satisfying the underlying purpose and need for the project.

Screening processes for eliminating alternatives with fatal flaws are generally employed. The aim is to eliminate infeasible concepts, ones that do not address the identified problems (that do not demonstrate a fit with the purpose and need), that cannot be reasonably engineered, that rely on untested technologies, and that are inconsistent with agency plans or policies. Cost alone cannot be used as the criterion for eliminating alternatives from consideration on projects following the NEPA process. There may be some circumstances, such as situations in which project funding is provided by a local ballot measure with a funding cap, where cost may be an acceptable screening criterion. Another example is when competing alternatives have similar benefits and impacts, but very different costs - eliminating the higher cost alternatives would be acceptable. Environmental impacts are also not generally used as screening criteria because there is no absolute standard for unacceptable levels of impact, or there are potential ways to mitigate the adverse effect. There always must be a trade-off analysis of the various benefits and impacts associated with the reasonable alternatives.

REFINE AND COMMIT TO MITIGATION STRATEGIES

Following selection of the preferred alternative, the CSD/CSS process encourages refinement of mitigation actions to be incorporated into the project, and formal commitment of resources to implement them. This allows for development of more accurate project cost estimates and easy tracking of commitments through the following phases of the project.

REFINING AND COMMITTING TO MITIGATION STRATEGIES

Public and agency comments on Draft EAs and EISs provide a basis for refinement of proposed mitigation strategies in NEPA processes. Final commitments are made through agency approvals of FONSIs and RODs. In projects not involving the NEPA process, or to cover agreements made between various state and local agencies that are not signatories to the FONSI or ROD, an interagency agreement or Memorandum of Understandings can be used to document agreements made by various project partners. Examples of such agreements are provided in Appendix E.

New York Route 110 Intermodal Transportation and Land Use Study

The primary goal of this study for the New York DOT was to identify options to reduce personal vehicle use in the Route 110 Corridor in the middle of Long Island. The study examined both transportation and land use practices using a three-dimensional computer-based simulation. A preliminary visualization tool—a video-based simulation of a significant intersection in the corridor—was used to inform the towns of Huntington and Babylon about the uses of visual simulation as a land use and transportation planning tool. Realistic traffic flow was correlated with the visual scene and presented in a live interactive session. This application also sets the stage for four-dimensional master planning—that is, including the element of time in simulated integrated transportation and land use planning.

IMPLEMENTATION

MONITOR CHANGES IN DESIGN AND MITIGATION

One likely result of CSD/CSS is improvement in the level of trust between transportation and resource agencies. Considering effects on environmental resources as an integral part of alternatives development, rather than an after thought following selection of the preferred alternative, will address many resource agency and public criticisms of transportation decision making processes. However, this trust can easily be broken if commitments made during the project development process are not honored during the final design and construction phases of the project. CSD/CSS calls for monitoring the project design and construction processes to identify changes that could affect implementation of agreed upon environmental impact avoidance, reduction, and mitigation measures. Continued consultation with resource and regulatory agencies throughout these processes is needed to ensure that inevitable changes do not increase impacts to unacceptable levels.

Appendix 12

Karst collapse
A rather extreme example of karst collapse occurred beneath a Warren County highway. When buildings or roads are constructed in areas of known subsurface cavities, great care must be taken in managing the surface drainage. Photo courtesy of Richard McGehee, Inspector, Field Operation Branch, Kentucky Division of Water.

Appendix 13

Tony Waltham
Fred Bell and
Martin Culshaw

Sinkholes and Subsidence

Karst and Cavernous Rocks in Engineering and Construction

Springer

Published in association with
Praxis Publishing
Chichester, UK

PRAXIS

Dr Tony Waltham
Lecturer in engineering geology
Civil Engineering Division
Nottingham Trent University
Nottingham
UK

Professor Fred. G. Bell
Visiting Research Associate
British Geological Survey
Keyworth
Nottinghamshire
UK

Martin G. Culshaw
Manager of the Urban Geoscience and Geological Hazards Programme
British Geological Survey
Keyworth
Nottinghamshire
UK

SPRINGER–PRAXIS BOOKS IN GEOPHYSICAL SCIENCES
SUBJECT *ADVISORY EDITOR*: Dr Philippe Blondel, C.Geol., F.G.S., Ph.D., M.Sc., Senior Scientist, Department of Physics, University of Bath, Bath, UK

ISBN 3-540-20725-2 Springer-Verlag Berlin Heidelberg New York

Springer is part of Springer-Science + Business Media (springeronline.com)

Bibliographic information published by Die Deutsche Bibliothek

Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available from the Internet at http://dnb.ddb.de

Library of Congress Control Number: 2004112901

Printed in Germany

Cover design: Jim Wilkie
Project Management: Originator Publishing Services, Gt Yarmouth, Norfolk, UK

Printed on acid-free paper

Case study #2

Collapse sinkhole at Dishman Lane, Kentucky

Patricia Kambesis and Roger Brucker

On a cold afternoon in February 2002, in the southern part of Bowling Green, Kentucky, rush hour traffic on Dishman Lane halted abruptly. A sinkhole 60 m across suddenly collapsed, dropping the road by 5 m. No-one was injured, but four cars were stranded on the subsided road. The cause was a catastrophic collapse of the main passage of State Trooper Cave (Figure 13.2.1), and the subsequent repairs to the road took nine months at a cost of a million dollars.

Back in 1987, the city of Bowling Green had proposed to extend Dishman Lane through the suburbs. The city is located in the Lost River drainage basin of the Sinkhole Plain of southern Kentucky, a part of the state at highest risk from collapse and flooding within the karst, so city engineers commissioned the Center for Cave and Karst Studies (CCKS) at Western Kentucky University to investigate the subsurface of the route of the proposed road.

State Trooper Cave had been mapped several years earlier as part of a regional cave study, prior to any road planning, and the cavers' compass-and-tape survey contained sketched cross sections but no profile. Their traverse extended from an upstream collapse entrance to a flooded zone 1,620 m downstream. The single trunk cave passage is mostly about 10 m wide and 5 m high, containing a river that

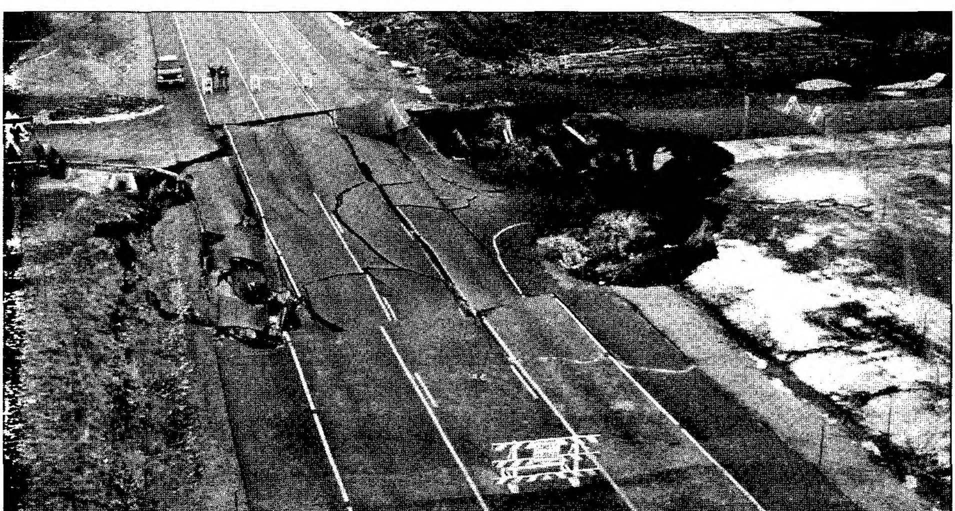


Figure 13.2.1. Aerial view of the collapse sinkhole in Dishman Lane, Bowling Green, seen looking towards the south-east
Photo: Centre for Cave and Karst Studies.

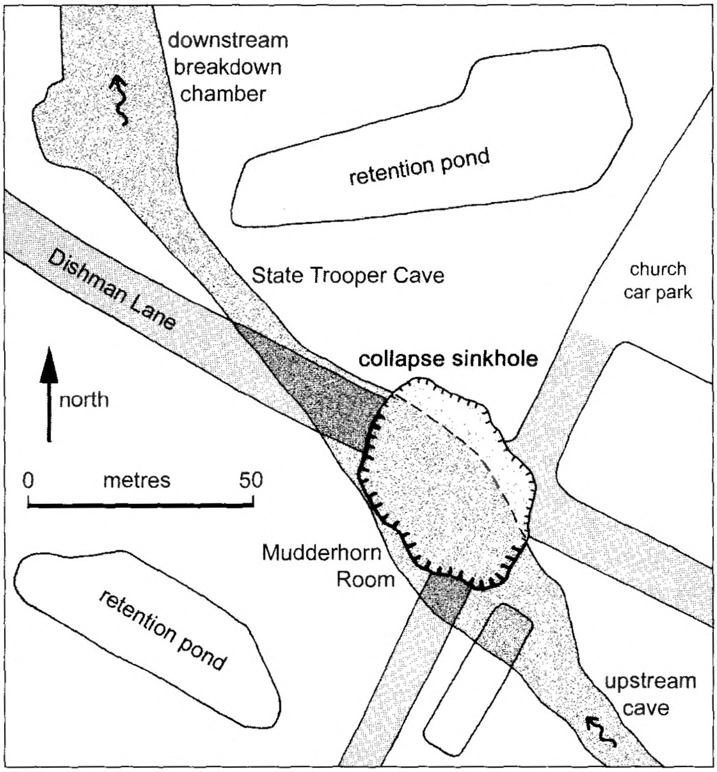


Figure 13.2.2. Outline map of the Dishman Lane sinkhole collapse and the cave beneath.

normally flows 1–3 m deep. It is a segment of the Lost River Cave that drains a basin area of about 92 km^2. Beneath the proposed Dishman Lane, the cave passage is widened and the ceiling rises due to breakdown to form the Mudderhorn Room (Figure 13.2.2); this was named after the thick layers of mud over massive fallen slabs, two of which projected upwards like glaciated horns. The cavers noted that the slightly domed ceiling of the room, several metres above the top of the breakdown debris, was cracked and fissured. Overhead, a condensation cloud could be seen on cold days, rising from the surface 10 m east of the main passage, in line with a tiny side passage draining from a waterfall dome.

In late 1987, the CCKS performed a microgravity survey to confirm the position of caves along the proposed road alignment, and made two low-frequency radio location fixes to confirm the cave room's exact position under the proposed road. The CCKS report recommended modification of the proposed straight road to avoid the Mudderhorn Room. Two curves in the road were suggested to take the road just north of the Mudderhorn, swinging wide of the breakdown and crossing the cave between the chamber and another breakdown area 150 m downstream.

At the request of the area developer, the city decided to place one gentle curve in the road to swing it just south of the downstream breakdown chamber, but elected to pave the road straight over the Mudderhorn Room. It appears that, by the time this decision was made, the original CCKS report had been forgotten or lost, and errors crept into maps that were newly prepared from inadequate data, so that the unstable cave chamber was thought to be away from the road line.

EVENTS OF THE COLLAPSE

In December 2001, cracks began to propagate in the brick walls of a new church being built adjacent to Dishman Lane. Motorists reported a new dip in the road, and protested the city's inaction by alerting the local newspaper. The city then dispatched an engineer to investigate the dip in the road. He concluded that there was no problem. CCKS was neither a party to, nor privy to, this investigation.

After the catastrophic collapse on February 25, investigators from the CCKS returned to the scene. They used a canoe to traverse the cave stream from an upstream entrance as far as the new collapse in Dishman Lane. At the former site of the Mudderhorn Room, they found daylight streaming in from several surface holes above the pile of new and old breakdown. Before the collapse, the Mudderhorn Room had been a wide section in the stream passage with a vaulted ceiling produced by breakaway of the horizontal limestone beds from the arch's tension zone. The mound of breakdown was partially covered by sediment, derived from periodic flooding and perhaps also from soil washed down through the ceiling fissures. After the collapse, loose rock extended from the streambed all the way to the surface along the north-east wall of the old cave room (Figure 13.2.3). The fall of the limestone roof had been followed by an avalanche of debris into the open cave, pushing boulders, cobbles and soil all the way from the north-east wall to the south-west wall. The cave stream flowed between the rocks at the base of this breakdown pile.

The ceiling of the downstream passage could not be seen as the new debris pile sealed off that part of the cave. The roof of the upstream cave passage appeared to be intact, with about 7 m of overburden rock and soil (Figure 13.2.4), and the room's southwestern wall appeared to be the stable original, rather than a freshly broken new surface. The entire rim of the new hole in the cave roof appeared to be along fresh breaks, as did all of the new breakdown blocks that lay over the old debris pile. Some of the new breakdown was coated with soil and sediment from above.

The CCKS investigators concluded that the southwestern wall of the cave room and its ceiling and those of the upstream passage appeared to be stable. The stream surface lay about 16 m below ground level, in a passage about 8.5 m high immediately upstream of the collapse. Additional investigations at the site included gravity surveys and 10 cored holes in and adjacent to the collapse (Kambesis *et al.*, 2003). These revealed voids at several levels above and below the cave passage level, with numerous clean fractures in the rock – consistent with typical cores drilled into the weathered Ste. Genevieve limestone elsewhere in Kentucky. The CCKS team concluded that further upstream collapse was unlikely, since the road alignment avoids the cave between the new collapse and the sink entrance and also the cave

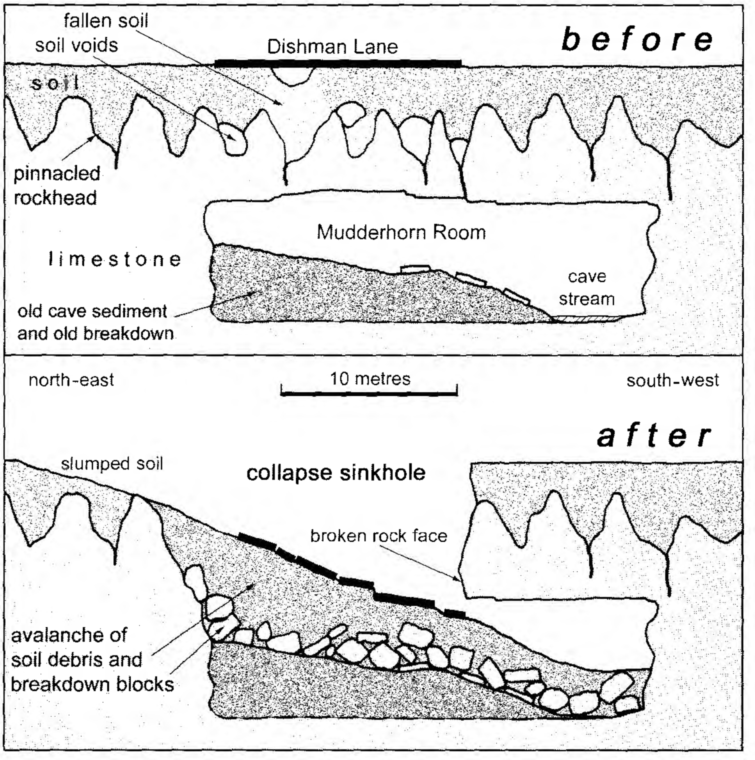


Figure 13.2.3. Cross sections of the cave beneath Dishman Lane before and after the collapse

Figure 13.2.4. The edge of the collapse zone under Dishman Lane, showing the deeply fissured limestone rockhead beneath the red clay soil cover.
Photo: Hilary Lambert, KEEP.

roof is thicker. Storm-water from the 8,000 m^2 church parking lot, from adjoining properties, and from Dishman Lane was still directed by ditches into the collapse during the nine-month repair period.

The Dishman Lane collapse had features of both bedrock and soil failure. The event was a culmination of factors that included the pre-existing weaknesses in the underlying bedrock and the effects of urban development on those weaknesses. State Trooper Cave is developed along a set of prominent joints that are evident from topographic maps and aerial photographs, and the Mudderhorn Room lies at the intersection of two major joints. Had conditions on the surface remained undisturbed, the low-arch roof profile developed by breakdown across the cave chamber, though very thin, would have remained stable (until it failed through dissolutional thinning over geological time).

However, the Dishman Lane area has undergone 20 years of significant development that involved both construction and the redirection of surface drainage. Placement of parking lots, streets, driveways and retention basins changed the run-off and infiltration characteristics of the soil mantle. Run-off from storm drains and from the edges of the road surface formed flow paths through the soil into open fissures between rockhead pinnacles in the limestone that was already weakened by its many solution channels. Steeper hydraulic gradients and flow velocities accelerated suffosion and removal of the soil, so that regolith arches developed over unstable voids. Because the roadbed acted as a bridging structure, the loss of soil was not apparent until one or more substantial voids had formed beneath it – setting the stage for a major regolith collapse. Since failure of the thin rock roof over the cave chamber was probably caused by a new emplacement of load, it appears likely that a regolith collapse triggered the bedrock collapse of the cave ceiling.

REMEDIATION

To repair the collapse and reinstate the road, three alternative approaches were presented by the CCKS:

- Remove the collapse debris and replace it with stacked large rocks from bedrock to a new road surface; this was the most permanent fix, but also the most costly.
- Find competent rock for foundations on both sides of the breach and completely bridge the sinkhole; in both these cases, the road could continue straight, but any fill in the sinkhole would need to be engineered with large blocks at the bottom to allow the stream to pass through without back-flooding.
- Curve the road around the sinkhole, as originally proposed, and leave the new rubble-filled sinkhole in place; while this was the cheapest option, it would add an unacceptable curve to a high-traffic road, would make access to existing properties awkward, and might still have problems with impeded floodwater.

Further alternatives, of a steel-reinforced roadbed, deep compaction, piled supports and pressure grouting, were considered and rejected.

The city engineers decided to completely excavate the collapsed material down to bedrock, one half at a time, and install a pre-cast concrete culvert 1.2 m in diameter to carry the stream. A vertical drain was also installed above a T-section to carry storm-water down from the repaved road and to allow access for clean-out and repairs. The culvert was covered over with graded aggregate, and the sinkhole was then backfilled with boulders from the excavated collapse, followed by smaller rocks and soil. The road was then rebuilt on its original straight alignment.

Potential future problems do remain. The newly placed rock pile forms a leaky dam in a cave passage that is 30–70 m^2 in cross section and does fill to the roof during storm events. When the much smaller, single, 1.2 m diameter culvert installed at stream level runs pipe-full, water could back up in the cave to cause upstream sinkhole flooding. The culvert size was chosen on the basis of incomplete data on the cave hydrology, and a double or triple culvert would have been more appropriate. Future flood events could destabilize the new fill by carrying trailing edge boulders downstream and thereby cause renewed subsidence of the road.

Six months after the completion of the repair, the church parking lot still drains onto the new road, where curbs carry the water to storm drains on each side that connect to the vertical culvert, as in any other injection well in the city. Adjacent drainage basins retain standing water. A dip in the road over the reconstructed area is being monitored regularly for any signs of renewed collapse.

Loss of the road was due to inadequate design procedures, where professional hydrogeological expertise was sought but then not applied. Designing the road on the basis of incorrect maps, when an earlier correct map had been lost or forgotten, was a catastrophic error in management of the ground investigation. It appears that the Dishman Lane collapse was totally avoidable.

Appendix 14

Environmental Assessment

Quiggins Sinkhole Flood Mitigation Project

City of Radcliff, Hardin County, Kentucky

DR-KY-1818-0012

February 12, 2015

U.S. Department of Homeland Security
Federal Emergency Management Agency – Region IV
Chamblee-Tucker Road – Hollins Building
Atlanta, GA 30341-411

SECTION ONE INTRODUCTION

The Department of Homeland Security's Federal Emergency Management Agency (FEMA) prepared this Environmental Assessment (EA) for the proposed construction of retention basins with sufficient capacity and other drainage elements to resolve frequent flooding in the City of Radcliff, Hardin County, Kentucky through a Hazard Mitigation Grant Program (HMGP) project under sub application number DR-KY-HMGP-1818-0012. FEMA provides HMGP funds to help protect people's lives, health, safety, and improved property.

In accordance with 44 CFR Part 10, FEMA Implementing Procedures, this EA has been prepared pursuant to Section 102 of the National Environmental Policy Act (NEPA) of 1969 (42 USC § 4332) and as implemented by the regulations promulgated by the President's Council on Environmental Quality (CEQ) (40 CFR parts 1500-1508). The purpose of the EA is to analyze the potential environmental impacts of the proposed action, and to determine whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI).

SECTION TWO PURPOSE AND NEED

The purpose of FEMA's HMGP program is to assist States and communities in rebuilding damaged communities and implementing measures that reduce or eliminate the long-term risk of future damages to infrastructure caused by severe storm events and natural disasters.

The need for this project is to eliminate damages to structures located around the project area and protect the use of two major thoroughfares in the City of Radcliff (City) – South Wilson Road and U.S. Route 31-W. These two roads carry a combined total of approximately 33,790 vehicles per day through the City. The City is adjacent to the U.S. Army's Fort Knox Military Base and most of the incoming and outgoing traffic from the base travels through the City on U.S Route 31-W and South Wilson Road. U.S. Route 31-W is also the major thoroughfare for Hardin County (see Appendix A, Figure 1 for overview map). Repetitive flooding from heavy rains (up to the 1.0 inch storm event) overtops South Wilson Road, causing closure of the road, trapping residents in homes, and causing the re-routing of 4,590 vehicles per day. Flooding from a very large rain event (i.e. 1 % chance storm event) will overtop U.S Route 31-W, causing the re-routing of approximately 29,200 vehicles per day. and flooding many structures in the area. In 1997, 54 homes and commercial businesses in the area were flooded from a 1% chance flood event.

A hydrological study of the existing Quiggins Sinkhole stormwater detention system was performed in 2009 to study the hydrogeology of karst flooding of the Happy Valley drainage area. The study concluded that the Quiggins Sinkhole was capable of discharging floodwaters at approximately 11.9 cubic feet per second (cfs) (about the same flow capacity of a 12-inch pipe or smaller) and that any storm event producing more than one inch of rain in six hours, with vegetation dormant and soil moisture high, would easily flood the sinkhole area.

Based on the history of flooding associated with the volume of water draining into Quiggins Sinkhole after heavy rain events, FEMA has determined that a need exists to provide flood protection for this area of the City.

SECTION THREE ALTERNATIVES

The following section describes the alternatives that were considered in addressing the purpose and need stated in Section Two. In this EA, two alternatives are evaluated: the No Action Alternative and the Proposed Action Alternative (construction of the Quiggins Sinkhole Flood Mitigation Project). Two additional alternatives were considered and were dismissed as they are not feasible for solving the flooding problem.

3.1 ALTERNATIVE 1: NO ACTION

Under the No Action Alternative, the existing drainage into the Quiggins Sinkhole would not change. Frequent flooding would continue to occur due to the large volume of stormwater runoff and the limited intake capacity of the sinkhole.

Under the No Action Alternative both residential and commercial/industrial properties would continue to be flooded, resulting in flood-related property damages. In addition, South Wilson Road and U.S. Route 31-W would continue to be severely impaired during flood events in this portion of the City of Radcliff.

3.2 ALTERNATIVE 2: PROPOSED ACTION

The City proposes to resolve the flooding that frequently occurs within the Happy Valley drainage area by constructing retention basins with sufficient capacity. The project area is located along South Wilson Road and U.S. Route 31-W. The Proposed Action is intended to greatly reduce or eliminate flooding during a 1% chance flood event. The Area of Potential Effect (APE) for the proposed detention basins consists of five separate areas along U.S. Route 31-W and South Wilson Road. The City has also included for review an alternate detention basin site in the event one of the proposed detention sites is not feasible once project construction begins. This site shall be further known as the “Alternate Detention Basin” in this document. Shelby Avenue comprises the northernmost boundary, with Joe Prather Highway comprising the southernmost boundary.

The City already owns the areas that will serve as the proposed and alternate detention basins. These properties will be used as green space in perpetuity. Deed restrictions will prevent development on these properties, which will further reduce flooding risks.

The majority of the project activities would be conducted in the northern part of the project area in an existing depressional area, proposed to be called the Quiggins Basin. The project would begin by clearing vegetation from approximately 24 acres of land within the depressional area once the depressional area is cleared, approximately 132,472 cubic yards of material would be excavated. Following excavation, the surface of the basin would be compacted and approximately 34,561 cubic yards of fill material could be replaced to level the basin. The remaining approximately 97,911 cubic yards of spoils material would be hauled from the site and disposed of at a fill/spoils disposal site located adjacent to the west of U.S. Route 31-W, between the proposed Turner and Quiggins Basins. The newly compacted basin would then be cleaned and hydrologic ally connected to the Quiggins Sinkhole with a box culvert, associated piping to the basin, and two newly constructed headwalls on either side of the culvert.

A low flow channel of approximately 1,530 linear feet would be constructed to connect the proposed drainage within the Quiggins Basin to the existing Quiggins Sinkhole through the box culvert and associated piping. Approximately 1,500 linear feet of old chain link fencing would be removed and replaced with a four-foot chain link fence at the existing sinkhole site and a gate would be installed to permit routine site access. Erosion-control fencing and best management practices (BMPs) would be used to minimize sedimentation of the waters entering the Quiggins Sinkhole. The newly constructed basin would be seeded with native grasses to stabilize and protect the surface of the basin and prevent erosion.

In addition to the Quiggins Basin, the construction of four additional basins (proposed Wilson, Cato, Turner and Song) will increase stormwater detention capacity during peak storm events. These additional basins would retain stormwater temporarily to allow the Quiggins Sinkhole to drain the stormwater more effectively. The four basins would collectively cover approximately 24 acres; the Wilson Basin would be approximately 7 acres, the Cato Basin approximately 6 acres, the Turner Basin approximately 6 acres, and the Song Basin approximately 5 acres. At each of the basin sites, the land would be cleared of existing vegetation and the individual proposed basins would be excavated, graded, compacted, and revegetated to stabilize the basin surface. Outlet structures from each basin with piping and headwalls would be constructed to connect the individual basins to the Quiggins Basin. A utility cut under Wilson Road to convey the water from these basins to the Quiggins Basin would also be required. For each basin site, erosion control measures, including silt fencing and individual BMPs, would be used to limit surface erosion and silt generation. Each basin would be mechanically compacted and revegetated with native grasses to stabilize the basin surface.

An off-site fill/spoils disposal area has been designated adjacent to the west side of U.S. Route 31-W, between the Turner and Quiggins Basins. The spoils disposal area consists of approximately 9 acres of vacant, mostly unwooded land. Limited clearing of scrub-shrub vegetation (generally consisting of three to four-inch saplings) would take place along U.S. Route 31-W. Once established, the spoils disposal area would be graded to provide smooth contours and to incorporate the use of erosion-control measures to prevent the site from generating silt load to any of the five basin areas. The spoil disposal site would then be revegetated with native grasses (See Appendix A, Figure 2 for all proposed project locations and Appendix B for photos of the proposed project area).

3.3 ALTERNATIVES CONSIDERED AND DISMISSED

Option 1: Enlarging the karst area underground. Due to the unique karst geology of the area, nearly 100 percent of surface water is transported away from the City by sinkholes. Further analysis of this alternative has deemed it to be cost-prohibitive while only minimally addressing the lack of floodwater storage capacity.

Option 2: Construction of a large storm water pump station designed to pump the excess storm water to an offsite area. To accomplish this, 7,600 linear feet of twin 36-inch diameter force mains would need to be constructed to convey the storm water away from the Quiggins Sinkhole area. The water would be pumped to a downstream discharge point, remote from the portion of the Happy Valley Drainage area that is currently subject to flooding impacts. Due to the huge stormwater flows entering the Quiggins Sinkhole and current depressional area (more than 1,000 cfs (7,479 gallons) per second during a heavy storm event), very large pumps would need to be installed at the site. Even with the use of these pumps, the reserve storage area of the existing depressional area would be insufficient to handle the peak storm flows. As a result, it would be necessary to enlarge the existing depressional area to store a larger volume of the storm water until the pumps could remove the excess volume. The pump station would need to be equipped with three pumps (one of which would be used as a backup pump in case of mechanical issues with the other two pumps) and would need to be equipped with a stand-by generator for power outages.

The costs, logistics, construction requirements, equipment and pipeline routing needs and overall project disruption to the main roadways within the City, when considered collectively, render this alternative not viable for solving the flooding problem.

SECTION FOUR AFFECTED ENVIRONMENT AND IMPACTS

The City is located in Hardin County, Kentucky; near the center of the state. The City is approximately 20 miles southwest of the greater Louisville, Kentucky, metropolitan area. The proposed project is located in the City's Happy Valley drainage area that covers approximately 1.74 square miles. The major road that bisects the project area is U.S. Route 31-W, which is the major thoroughfare for the City and Hardin County. The approximate central coordinates of the proposed project area are latitude 37.811086 and longitude -85.918986.

The following table summarizes the potential impacts of the No Action Alternative and the Proposed Action Alternative and conditions or mitigation measures to offset those impacts. Following the summary table, any resource areas for which potential impacts were identified, as well as high-priority resources, including floodplains, Waters of the U.S (WOUS), environmental justice, biological resources, and cultural resources, are discussed in greater detail.

APPENDIX C

REPORTS

QUIGGINS HYDROLOGIC STUDY

Architecture Engineering Planning

Groundbreaking by Design.

Prepared for:

RADCLIFF

CITY OF RADCLIFF
Engineering Department
411 West Lincoln Trail Boulevard
Radcliff, Kentucky 40159

Prepared by:

Architecture
Engineering
Planning

815 West Market Street
Suite 300
Louisville, KY 40202
Ph. (502) 585-2222
Fx. (502) 581-0406

Prepared:

February 2009

5. Summary of Results

A. Flood Elevations

Many of the road closures, specifically at South Wilson Road, due to flooding from the Quiggins Sinkhole are caused by storms of lesser magnitude than the 1-year event. Excavation and enlargement of the ponding area of Quiggins Sinkhole nearly eliminates overtopping of South Wilson Road for less than the 1-year storm event. Also, excavation of the Quiggins Sinkhole reduces almost four days of closure time of South Wilson Road for all the 1-year through the March, 1997 flood events.

Excavation of Quiggins Sinkhole plus the construction of four additional basins eliminates overtopping of South Wilson Road for the less than 1-year, the 1-year and 2-year storm events. In addition, there is a reduction of up to 10 days of annual closure time for South Wilson Road for the 5-year through the March, 1997 flood events.

Excavation of Quiggins Sinkhole would lower the 100-year flood elevation by 1.1' and reduce the number of days of South Wilson Road closure from approximately 21 to 17 per year. Excavation of Quiggins Sinkhole plus the construction of four basins would lower the 100 year flood elevation by 4' and reduce the number of days of South Wilson Road closure from approximately 21 days to 10 days per year.

Excavation of Quiggins Sinkhole would lower the 1997 flood elevation by 0.8' and reduce the number of days of South Wilson Road closure from approximately 25 days to 21 days per year. Excavation of Quiggins Sinkhole plus the construction of four basins would lower the 1997 flood elevation by 3.2' and reduce the number of days of South Wilson Road closure from approximately 25 days to 14 days per year.

Table 19 summarizes the flood elevations for each scenario. See exhibits 3 - 11 (behind *Exhibit* tab) for a graphic representation of the flood elevation reductions for each scenario.

B. Sediment Control/Water Quality

In addition to flood control, the construction of the four basins may enhance water quality. Sediments collected by the excess runoff can settle out while the rainfall is being temporarily impounded in the constructed basins. The City of Radcliff plans to impound the stored runoff in the basins for the entire duration of each rainfall event and beyond to allow sinkhole backwater to subside. During this period many of the suspended sediments will settle out.

Appendix 15

DESIGN MEMORANDUM NO. 12-05

TO:	Chief District Engineers Design Engineers Active Consultants
FROM:	David E. Kratt, Acting Director DeK Division of Highway Design
DATE:	July 27, 2005
SUBJECT:	Policy on Best Management Practice (BMP) to be used for Karst and Significant Resource Areas

The following BMP shall be used during the construction and the maintenance/operations of all roads listed on the National Highway System located in Karst areas and on all roadways which may impact a significant resource as determined by the DEA.

1. **Use grass swales for ditches. These swales shall be constructed as shown on the attached detail with a flat bottom cross-section of 2 ft. minimum. The width of the bottom of the swale will be determined by the Design Engineer based on the expected peak flow and the slope so that resulting shear stress will allow as much grass or grass and geo-tech liner as possible.**

2. **Use interceptor ditches to prevent large volumes of off site water from adding to the volume of run-off being carried by the swales.**

3. **Use detention/containment basins to temporarily impound the run-off from the swales before it is discharged from the right-of-way. These basins shall have a minimum volume of 10,000 gallons upstream from each final discharge point. This volume may be attained by constructing basins in series if necessary. The discharge point of each basin shall be constructed as a Silt Trap Type B (see attachment). Detention Basins shall be designed to maximize the flow length between the entrance and exit.**

4. **All swales shall be seeded with the mixture shown on the detail at the rate of 5 lbs. per 1000 sq. ft.**

5. **When and if these swales and/or basins are cleaned out, they shall be restored.**

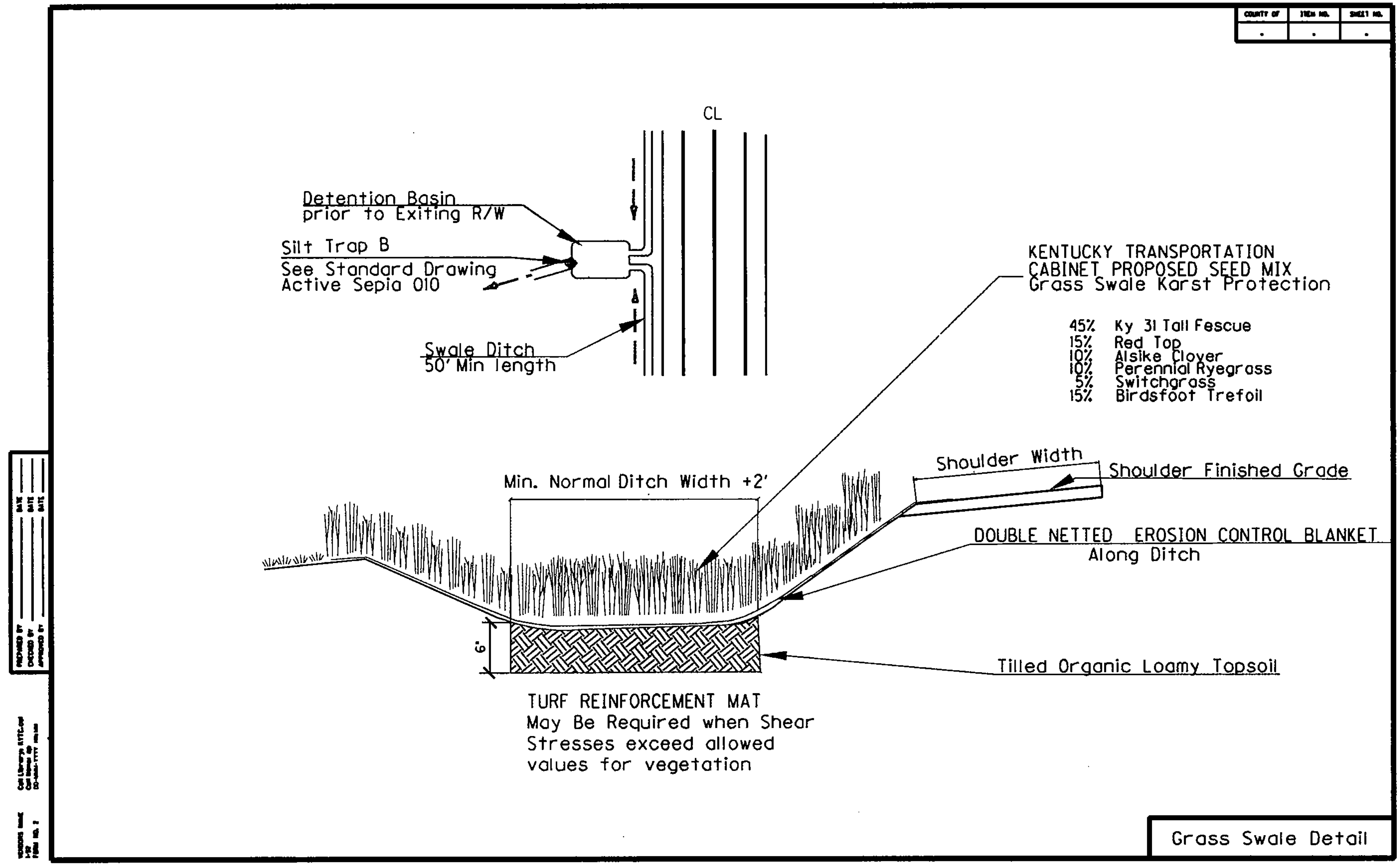
This policy is effective for the Design Projects for I-65 and I-66 which are currently being designed and for all other qualifying projects where Right-of-Way plans have not been completed. The Project Team may decide to implement this policy on projects that do not meet the above criteria.

As this is a new policy, details and techniques will need to be further refined as we gain experience with the procedures enumerated above. Please contact Mr. Danny Jasper of the Division of Highway Design with your comments, suggestions or questions.

Maps of the National Highway System are located on the Division of Planning's website at http://transportation.ky.gov/planning/maps/NHS/nhs_kysz_2005.pdf. The Area of Karst Occurrence in Kentucky is located on the Kentucky Geological Survey's website at http://kgsweb.uky.edu/olops/pub/kgs/mc33_12.pdf. A detail of a Grass Swale is attached.

DEK:RDM:WDM:DJ:JAD

Attachment



...\DetentionDamVegSwaleDetail.dgn 7/8/2005 11:37:51 AM

Appendix 16

U.S. Department of the Interior
U.S. Geological Survey

Assessing Biological Effects from Highway-Runoff Constituents

Open-File Report 99-240

A Contribution to the
National Highway Runoff Data and Methodology Synthesis

U.S. Department
of Transportation

USGS
science for a changing world

from 22 to 66 percent of samples taken in places where MTBE was in current use as a gasoline additive (Delzer and others, 1996). MTBE is quite volatile and would be expected to dissipate rapidly from soil or water surfaces (U.S. Environmental Protection Agency, 1993a). However, MTBE is about 40 times more soluble than the BTEX compounds and is less biodegradable than many common gasoline hydrocarbons. As a result, it is expected to be comparatively more persistent in ground water and in the shallow, fast-moving streams that are typical of urban and highway-runoff conveyances (Delzer and others, 1996). MTBE has been found in ground-water supplies at levels in excess of 200 milligrams per liter (mg/L) in some locations (U.S. Environmental Protection Agency, 1993b), posing a potential exposure risk to humans and aquatic life.

Sediment comprises inorganic and organic material and can be transported by, suspended in, or deposited by stormwater. Suspended sediment is generally considered to be one of the most substantial nonpoint-source contaminants (Waters, 1995; Crawford and Mansue, 1996). Studies across the Nation have documented that sediment can have large effects on the biology of receiving waters, ranging from the burial of fish eggs to the destruction of the entire aquatic food chain (Waters, 1995; Simmons, 1993). Many contaminants, including some metal ions, organic chemicals, and nutrients, are transported by sediment (Crawford and Mansue, 1996). Sediments have been associated with the destruction of aquatic habitat and a decrease in aquatic populations. Even relatively moderate sediment loading to an otherwise healthy stream can reduce the variety and abundance of aquatic life (Waters, 1995; Crawford and Mansue, 1996; Simmons, 1993). Sediment loads can also cause engineering problems by decreasing the capacity of channels and impoundments.

Although they receive only limited use in vegetation control for highway maintenance, herbicides and other agricultural chemicals are frequent components of nonpoint-source pollution. When a specific product is used intentionally for highway-maintenance activities, it is a relatively straightforward process to estimate the risk associated with the use of that product. Regardless of the actual sources, herbicides, pesticides, and other agricultural products frequently occur in surface-water runoff and should be given consideration in evaluations of nonpoint-source pollution.

Other Factors

Although outside the scope of this report, other factors may influence the health and abundance of individual organisms and biotic communities at a study site, such as spills of hazardous substances, physical habitat disturbance, and thermal pollution. Other factors of particular interest to the study and interpretation of apparent biological effects of highway-runoff quality are contamination and habitat disturbance caused by periodic highway construction and maintenance, hazardous substance spills, and other construction/development in the study area. Knowledge of the potential biological effects caused by these factors is important to assess results of a study to be included in a national or regional characterization of highway runoff. The effects caused by a spill or habitat disturbance from upstream development could potentially overshadow effects caused by highway-runoff discharges into receiving waters.

The high concentrations of chemicals caused by episodic spills of fuel, lubricants, coolant, and other chemicals are not normally considered to be characteristic of highway-runoff constituent concentrations. Spills, however, should be documented because a spill can affect measured water quality, and can affect biota in receiving waters. Unlike vehicle emissions or chemicals that are intentionally applied during highway construction and maintenance, the entry of contaminants into the environment from spills of hazardous substances is much less predictable. Large amounts of a wide array of hazardous materials are routinely transported on the Nation’s highways. Examples include fuels, agricultural chemicals, industrial compounds, and hazardous-waste products. About 2,400 chemical spills on the Nation's highways are reported to Federal authorities each year (National Response Center, 1999), and about 7,000,000 traffic accidents are reported by police to the National Highway Safety Administration each year (Cerrelli, 1998, 1997). McNeill and Olley (1998) noted the effects of small "routine spills"caused by traffic accidents on highway-runoff water quality, and upon stream biota at sites in their study area, and concluded that runoff best-management practice (BMP) structures should be designed to retain these small spills for cleanup. Because both minor and major spills can bias interpretations about the quality of highway runoff and the effects of highway runoff on biota, such events should be tracked and noted as explanatory variables for the data set collected at a given site. Once an accident occurs, the volume and types of contaminants that were released can usually be readily defined and appropriate measures for evaluating the nature and extent of the problem can be identified.

Although it is not specifically an environmental-contaminant concern, the potential for physical habitat disturbance in a highway-runoff study area is of great interest for site selection. Sedimentation and soil erosion, loss and changes in vegetation, physical habitat alteration, and disturbance of wildlife transport corridors are all potential concerns. Some of the most substantial biological changes caused by development are directly or indirectly related to altered hydrology. Despite efforts to use BMPs to attenuate the hydrologic effects of development, increased peak flows and more flashy runoff will cause physical modifications to the channel shape, bed substrate, and banks of receiving waters, with corresponding effects on aquatic habitat and biota. Loss of forest canopy, increases in paved area, and shallow and(or) muddy detention areas also may cause thermal pollution problems, which can exacerbate chemical stressors on aquatic organisms in receiving waters. All these factors will vary from site to site, and will affect interpretation of cause-and-effect relations between highway-runoff quality and the health and abundance of aquatic organisms in receiving waters.

BIOLOGICAL ASSESSMENT TECHNIQUES

The presence of measurable quantities of contaminants in the environment is an indicator of potential exposure. Contaminant presence alone, however, does not necessarily indicate the occurrence of deleterious biological effects. Measures of exposure must be linked to measures of effect in order to establish a causal relationship. Biological responses to contaminant exposure are the result of a progression of events that can be described as follows: The contaminant must first be released into the environment. This may be the result of intentional discharge, emission, or application. Contaminant input may also be due to unintentional releases such as spills, leakages, or other accidents. A variety of physical, chemical, and biological processes then come into play to determine the ultimate distribution, longevity, availability, and chemical form of the contaminant in the environment. The first interaction of the contaminant with an organism occurs at the biomolecular level. If the degree of exposure is sufficient to elicit a biochemical response, then there is the potential for effects at the tissue, organ, whole-organism, population, and community levels of biological organization.

Each level of biological organization has a resiliency, or assimilative capacity, that allows it to mitigate injury. In order for a contaminant to elicit an effect at the higher levels of organization (e.g., population or community levels), it must first exceed the ability of the lower levels to attenuate the response. For example, a 10 percent inhibition of an enzyme may or may not cause an observable response at the tissue, organ, or whole-organism level. The loss of a finite number of individuals may or may not be observable as an adverse effect on population status for some species. And finally, due to redundancy of function, the decline or loss of some populations may, or may not, observably affect the community if other species are able to fill those functional voids.

These relationships and interdependencies provide both promise and challenge to the use of biological responses as indicators of environmental health. Biochemical changes are the first biological responses that occur, therefore, they may be useful as early warning signals of contaminant problems. Effects at the biochemical level, however, may or may not result in measurable responses at the higher levels of biological organization. At the other end of the spectrum, many different physical, chemical, or ecological stressors can elicit apparently similar changes at the community level. As a result, it is often difficult to establish cause and effect at the higher levels of organization. The challenge facing the environmental scientist is to use the comparative specificity of responses at the lower levels of biological organization to help establish causal relationships with the more ecologically meaningful community levels. Measurement of effects at several levels of biological organization can provide a better understanding of the significance of a contaminant's presence, and can help determine whether a causal relationship exists.

In the remainder of this section, a variety of biological assessment techniques are discussed. No attempt has been made to provide an exhaustive review. Literally hundreds, if not thousands, of biological endpoints may be either directly, or associatively, affected by contaminant exposure. The techniques discussed below should be viewed simply as examples

Appendix 17

Groundwater Quality in Watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek (Kentucky Basin Management Unit 5)

R. Stephen Fisher[1]
Bart Davidson[1]
Peter T. Goodmann[2]

Abstract

The Kentucky Geological Survey and the Kentucky Division of Water are evaluating groundwater quality throughout the commonwealth to determine regional conditions, assess impacts of nonpoint-source contaminants, provide a baseline for tracking changes, and provide essential information for environmental-protection and resource-management decisions. These evaluations include summarizing existing regional groundwater-quality data and reporting the results of expanded, focused groundwater collection programs in specific areas. This report summarizes groundwater sampling and analysis in Kentucky basin management unit 5 (watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek in eastern Kentucky).

Thirty wells and springs were sampled quarterly between the fall of 2002 and the summer of 2003. Temperature, pH, and conductance were measured at the sample site, and concentrations of a selected group of major and minor inorganic ions, metals, nutrients, pesticides, and volatile organic chemicals were measured at the Kentucky Division of Environmental Services laboratory. The new analytical data were combined with groundwater-quality records retrieved from the Kentucky Groundwater Data Repository. This repository is maintained by the Kentucky Geological Survey and contains reports received from the Division of Water's Ambient Groundwater Monitoring Program as well as results of investigations by the U.S. Geological Survey, U.S. Environmental Protection Agency, U.S. Department of Energy, Kentucky Geological Survey, Kentucky Division of Pesticide Regulation, and other agencies. Statistical measures such as the number of measured concentrations reported, the number of sites sampled, quartile values (maximum 75th percentile, median, 25th percentile, and minimum), and the number of sites at which water-quality standards were exceeded were used to summarize the data, and probability plots were used to illustrate the distribution of reported concentrations. Maps were used to show well and spring locations and sites where water-quality standards were met or exceeded. Box-and-whisker diagrams were used to compare values between major watersheds, water from wells versus water from springs, and total versus dissolved metal concentrations. Plots of concentrations versus well depth were used to compare groundwater quality in shallow, intermediate, and deep groundwater flow systems.

Table A1 summarizes the findings. Water properties, inorganic anions, and metals are primarily controlled by natural factors such as bedrock lithology. Some exceptionally high values of conductance, chloride, and sulfate may be affected by nearby oil and gas production, leaking waste-disposal systems, or other human factors, and some exceptionally low pH values may in-

[1]Kentucky Geological Survey
[2]Kentucky Division of Water

Table 4. Parameters and water-quality standards used for data summaries.

	Parameter	Standard (mg/L unless otherwise noted)	Source
Water Properties	Conductance	10,000 µS	No MCL or SMCL; approximately corresponds to brackish water
	Hardness (calcium and magnesium)	Soft: 0–17 Slightly hard: 18–60 Moderately hard: 61–120 Hard: 121–180 Very hard: > 180	U.S. Geological Survey
	pH	6.5–8.5 pH units	SMCL
	Total dissolved solids	500	SMCL
	Total suspended solids	35	KPDES
Inorganic Ions	Chloride	250	SMCL
	Sulfate	250	SMCL
	Fluoride	4.0	MCL
Metals	Arsenic	0.010	MCL
	Barium	2.0	MCL
	Iron	0.3	SMCL
	Manganese	0.05	SMCL
	Mercury	0.002	MCL
Nutrients	Ammonia-nitrogen	0.110	DEP
	Nitrate-nitrogen	10.0	MCL
	Nitrite-nitrogen	1.0	MCL
	Orthophosphate-phosphorus	0.04	Texas surface-water standard
	Total phosphorus	0.1	NAWQA
Pesticides	2,4-D	0.07	MCL
	Alachlor	0.002	MCL
	Atrazine	0.003	MCL
	Cyanazine	0.001	HAL
	Metolachlor	0.1	HAL
	Simazine	0.004	MCL
Volatile Organic Compounds	Benzene	0.005	MCL
	Ethylbenzene	0.7	MCL
	Toluene	1.0	MCL
	Xylenes	10	MCL
	MTBE	0.050	DEP

MCL: Maximum contaminant level (U.S. Environmental Protection Agency). Concentrations higher than the MCL may present health risks.
SMCL: Secondary maximum contaminant level (U.S. Environmental Protection Agency). Concentrations greater than the SMCL may degrade the sight, smell, or taste of water.
NAWQA: National Water-Quality Assessment Program (U.S. Geological Survey). Higher concentrations may promote algal growth and eutrophication.
HAL: Health advisory level. Higher concentrations may have an impact on human health.
KPDES: Kentucky Pollution Discharge Elimination System. Standard set for water-treatment facilities.
DEP: Kentucky Department for Environmental Protection risk-based concentration. Higher concentrations may present health risks.

Appendix 18

Water-Resources Investigations Report 97-4097

Preliminary Conceptual Models of the Occurrence, Fate, and Transport of Chlorinated Solvents in Karst Regions of Tennessee

Prepared by the
U.S. GEOLOGICAL SURVEY

in cooperation with the
TENNESSEE DEPARTMENT OF ENVIRONMENT
AND CONSERVATION, DIVISION OF SUPERFUND

Preliminary Conceptual Models of the Occurrence, Fate, and Transport of Chlorinated Solvents in Karst Regions of Tennessee

By William J. Wolfe, Connor J. Haugh, Ank Webbers, *and* Timothy H. Diehl

Abstract

Published and unpublished reports and data from 22 contaminated sites in Tennessee were reviewed to develop preliminary conceptual models of the behavior of chlorinated solvents in karst aquifers. Chlorinated solvents are widely used in many industrial operations. High density and volatility, low viscosity, and solubilities that are low in absolute terms but high relative to drinking-water standards make chlorinated solvents mobile and persistent contaminants that are difficult to find or remove when released into the ground-water system. The major obstacle to the downward migration of chlorinated solvents in the subsurface is the capillary pressure of small openings. In karst aquifers, chemical dissolution has enlarged joints, bedding planes, and other openings that transmit water. Because the resulting karst conduits are commonly too large to develop significant capillary pressures, chlorinated solvents can migrate to considerable depth in karst aquifers as dense nonaqueous-phase liquids (DNAPL's). Once chlorinated DNAPL accumulates in a karst aquifer, it becomes a source for dissolved-phase contamination of ground water. A relatively small amount of chlorinated DNAPL has the potential to contaminate ground water over a significant area for decades or longer.

Conceptual models are needed to assist regulators and site managers in characterizing chlorinated-solvent contamination in karst settings and in evaluating clean-up alternatives. Five preliminary conceptual models were developed, emphasizing accumulation sites for chlorinated DNAPL in karst aquifers. The models were developed for the karst regions of Tennessee, but are intended to be transferable to similar karst settings elsewhere. The five models of DNAPL accumulation in karst settings are (1) trapping in regolith, (2) pooling at the top of bedrock, (3) pooling in bedrock diffuse-flow zones, (4) pooling in karst conduits, and (5) pooling in isolation from active ground-water flow.

More than one conceptual model of DNAPL accumulation may be applicable to a given site, depending on details of the contaminant release and geologic setting. Trapping in regolith is most likely to occur where the regolith is thick and relatively impermeable with few large cracks, fissures, or macropores. Accumulation at the top of rock is favored by flat-lying strata with few fractures or karst features near the bedrock surface. Fractures or karst features near the bedrock surface encourage migration of chlorinated DNAPL into karst conduits or diffuse-flow zones in bedrock. DNAPL can migrate through one bedrock flow regime into an underlying flow regime with different characteristics or into openings that are isolated from significant ground-water flow.

As a general rule, the difficulty of finding and removing DNAPL increases with depth, lateral distance from the source, and complexity of the ground-water flow system. The prospects for mitigation are generally best for DNAPL accumulation in the regolith or at the bedrock surface. However, many such accumulations are likely to be difficult to find or remove. Accumulations in bedrock diffuse-flow zones or in fractures isolated from flow may be possible to find and partially mitigate, but will likely leave significant amounts of contaminant in small fractures or as solute diffused into primary pores.

Appendix 19

U.S. Department of Transportation
Federal Highway Administration

OFFICE OF PLANNING, ENVIRONMENT, AND REALTY
PROJECT DEVELOPMENT AND ENVIRONMENTAL REVIEW
WASHINGTON, DC 20590

SECTION 4(f) POLICY PAPER

JULY 20, 2012

Section 4(f) Policy Paper. In situations where FHWA has determined that Section 4(f) does not apply, the project file should contain sufficient information to demonstrate the basis for that determination (*See* Section 4.0, *Documentation*).

2.0 Background

The FHWA originally issued the *Section 4(f) Policy Paper* in 1985, with minor amendments in 1989. A 2005 edition provided comprehensive new guidance on when and how to apply the provisions of Section 4(f), including how to choose among alternatives that all would use Section 4(f) property. Later in 2005, Congress substantially amended Section 4(f) in the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU), (Pub. L. 109-59 (Aug. 10, 2005), 119 Stat. 1144). SAFETEA-LU directed the U.S. DOT to revise its Section 4(f) regulations. In response, FHWA and the Federal Transit Administration consulted with interested agencies and environmental organizations before drafting a notice of proposed rulemaking. The notice of proposed rulemaking was published for comment in the Federal Register (71 *Fed. Reg*. 42611, July 27, 2006).

Following careful consideration of the comments submitted, the new Section 4(f) regulations were issued in March 2008 (73 *Fed. Reg*.13368, March 12, 2008). A minor technical correction followed shortly thereafter (73 *Fed. Reg.* 31609, June 3, 2008). The new Section 4(f) regulations clarified the feasible and prudent standard, implemented a new method of compliance for *de minimis* impact situations, and updated many other aspects of the regulations, including the adoption of regulatory standards based upon the 2005 edition of the *Section 4(f) Policy Paper* for choosing among alternatives that all use Section 4(f) property. This 2012 edition of the *Section 4(f) Policy Paper* includes guidance for all of the changes promulgated in the Section 4(f) regulations in 2008.

If any apparent discrepancy between this *Section 4(f) Policy Paper* and the Section 4(f) regulation should arise, the regulation takes precedence. The previous editions of this *Section 4(f) Policy Paper* are no longer in effect.

3.0 Analysis Process

3.1 Identification of Section 4(f) Properties

Section 4(f) requires consideration of:

- Parks and recreational areas of national, state, or local significance that are both publicly owned and open to the public
- Publicly owned wildlife and waterfowl refuges of national, state, or local significance that are open to the public to the extent that public access does not interfere with the primary purpose of the refuge[6]

[6] Since the primary purpose of a refuge may make it necessary for the resource manager to limit public access for the protection of wildlife or waterfowl, FHWA's policy is that these facilities are not required to always be open to

- Historic sites of national, state, or local significance in public or private ownership regardless of whether they are open to the public (*See* 23 U.S.C. § 138(a) and 49 U.S.C. § 303(a))

When private institutions, organizations, or individuals own parks, recreational areas or wildlife and waterfowl refuges, Section 4(f) does not apply, even if such areas are open to the public. However, if a governmental body has a permanent proprietary interest in the land (such as a permanent easement, or in some circumstances, a long-term lease), FHWA will determine on a case-by-case basis whether the particular property should be considered publicly owned and, thus, if Section 4(f) applies (*See* Questions 1B and 1C). Section 4(f) also applies to all historic sites that are listed, or eligible for inclusion, in the National Register of Historic Places (NR) at the local, state, or national level of significance regardless of whether or not the historic site is publicly owned or open to the public.

A publicly owned park, recreational area or wildlife or waterfowl refuge must be a significant resource for Section 4(f) to apply (*See* 23 CFR 774.11(c) and Question 1A). Resources which meet the definitions above are presumed to be significant unless the official with jurisdiction over the site concludes that the entire site is not significant. The FHWA will make an independent evaluation to assure that the official's finding of significance or non-significance is reasonable. In situations where FHWA's determination contradicts and overrides that of the official with jurisdiction, the reason for FHWA's determination should be documented in the project file and discussed in the environmental documentation for the proposed action.

Section 4(f) properties should be identified as early as practicable in the planning and project development process in order that complete avoidance of the protected resources can be given full and fair consideration (*See* 23 CFR 774.9(a)). Historic sites are normally identified during the process required under Section 106 of the NHPA and its implementing regulations (*See* 36 CFR Part 800). Accordingly, the Section 106 process should be initiated and resources listed or eligible for listing in the NR identified early enough in project planning or development to determine whether Section 4(f) applies and for avoidance alternatives to be developed and assessed (*See* 23 CFR 774.11(e)).

3.2 Assessing *Use* of Section 4(f) Properties

Once Section 4(f) properties have been identified in the study area, it is necessary to determine if any of them would be used by an alternative or alternatives being carried forward for detailed study. *Use* in the Section 4(f) context is defined in 23 CFR 774.17 (*Definitions*) and the term has very specific meaning (*see* also Question 7 in this *Section 4(f) Policy Paper*). Any potential use of Section 4(f) property should always be described in related documentation consistent with this definition, as well as with the language from 23 CFR 774.13(d) (*Exceptions- temporary occupancy*) and 23 CFR 774. 15 (*Constructive Use Determinations*), as applicable. It is not recommended to substitute similar terminology such as affected, impacted, or encroached upon in describing when a use occurs, as this may cause confusion or misunderstanding by the reader.

---

the public. Some areas of a refuge may be closed to public access at all times or during parts of the year to accommodate preservation objectives.

Appendix 20

RADCLIFF/ELIZABETHTOWN
METROPOLITAN PLANNING ORGANIZATION

UNIFIED PLANNING WORK PROGRAM
FISCAL YEAR 2014

Planning for the transportation needs of the region.

APRIL 2013

LINCOLN TRAIL AREA DEVELOPMENT DISTRICT
P.O. BOX 604
613 COLLEGE STREET ROAD
ELIZABETHTOWN, KENTUCKY 42702-0604

METROPOLITAN PLANNING ORGANIZATION COMMITTEES

Policy Committee

Harry Berry, Hardin County Judge/Executive, Chairman
J. J. Duvall, Mayor, City of Radcliff, Vice-Chairman
Gerry Lynn, Meade County Judge/Executive
Tim Walker, Mayor, City of Elizabethtown
David Pace, Mayor, City of Brandenburg
Blake Proffitt, Mayor, City of Vine Grove
Patty Dunaway, Chief District Engineer, KYTC Dept. of Highways, District 4
    >Secretary, Kentucky Transportation Cabinet Proxy
Emmet Holley, Garrison Manager, Fort Knox (Ex Officio)
Jodi Alford, Executive Director, Transit Authority of Central Kentucky (TACK) – (Ex Officio)
Jose Sepulveda, Division Administrator, FHWA (Ex Officio)
Yvette Taylor, Regional Administrator, FTA, Region 4 (Ex Officio)

Technical Advisory Committee

Vicki Meredith, Hardin County Engineer, Chairperson
Murray Wanner, City Planner, City of Radcliff, Vice-Chairperson
Kevin Young, Planning, District 4, Department of Highways
Barry House, Transportation Eng. Specialist, KYTC Div. of Planning
Ed Poppe, Planning and Development Director, City of Elizabethtown
Scott Reynolds, City Engineer, City of Elizabethtown
Adam King, Hardin County Planning and Development
Chris Mayhew, Planning Coordinator, City of Vine Grove
David Underwood, Hardin County Emergency Services Director
Toby Spalding, City of Radcliff Engineer
Warren Clifford, Fort Knox Engineering Services
Mike Hall, Owner, Transportation Management Systems
Jodi Alford, Executive Director, Transit Authority of Central Kentucky (TACK)
Vickie Bourne, Exec. Dir., KYTC Office of Trans Delivery
Bernadette Dupont, Transportation Specialist, FHWA (NON-VOTING)
Robert Buckley, Federal Transit Administration (NON-VOTING)

MPO Transportation Planning Staff

Mike Skaggs, MPO Transportation Planner

III. RESPONSIBILITIES, COOPERATION, AND COORDINATION

A. FEDERAL

1. Federal Highway Administration

The Federal Highway Administration (FHWA), US Department of Transportation is responsible for administering all federal highway funds available for highway planning and implementation pursuant to the provisions of Title 23, United States Code. The Federal Highway Administration is responsible, through the State Division Office, for issuing to the Kentucky Transportation Cabinet (KYTC) all regulations and guidelines relative to expenditure of federal highway funds; monitoring all highway planning, programming and implementation activities; periodic reviews to certify the planning process.

By virtue of having a Division Office within the State, the Federal Highway Administration provides a degree of liaison between state transportation agencies and regional federal modal agencies. The Kentucky Division Office has representation on the Technical Advisory Committee (TAC) and Policy Committee and actively participates in all transportation efforts but is not a voting member of either committee.

2. Federal Transit Administration

The Federal Transit Administration (FTA), US Department of Transportation is responsible for administering all federal transit funds available through grant allocation for public transportation planning, capital improvement, demonstration and operations pursuant to the provisions of Title 49 United States Code. The Federal Transit Administration, through the Regional Office, is responsible for: issuing to all grant recipient agencies and public transportation operators regulations and guidelines relative to the expenditure of transit funds; monitoring public transportation planning and demonstration projects; and fiscal controls.

3. Other Federal Agencies

Other federal agencies such as the Federal Aviation Administration, US Army Corps of Engineers, Federal Railroad Administration, and Environmental Protection Agency may provide the Radcliff/

Elizabethtown MPO with review and advisory assistance on an as needed basis.

B. STATE

1. Kentucky Transportation Cabinet

The Kentucky Transportation Cabinet (KYTC) is responsible for preparation of long range, coordinated, statewide transportation plans; development of a data collection program relative to all transportation modes and needs; encouragement and promotion of the development of transportation systems embracing various modes of transportation in a manner that will serve the State and local communities effectively and efficiently; and cooperation with local governments in the development of long range transportation plans. The Radcliff/Elizabethtown MPO and KYTC must cooperate and coordinate their respective actions and programs very closely.

KYTC discharges its legislated and delegated responsibility as follows:

a. KYTC Division of Planning

The Division of Planning is responsible for ensuring that any program or project involving state or federal funds or aid is based on a continuing and comprehensive planning process carried on cooperatively by the state and local communities.

The Division of Planning is also responsible for the ongoing data collection program which provides inventories of all transportation modes and needs; development of transportation plans, needs and programs; administering and conducting transportation research programs; and liaison between the KYTC and Federal Highway Administration. Financial forecasts of Federal and State allocations of transportation funding will be provided to the Radcliff/Elizabethtown MPO.

The Division of Planning is also responsible for conducting air quality conformity analysis in areas outside the MPO boundaries but within designated non-attainment or maintenance areas.

b. KYTC Office of Transportation Delivery

The Office of Transportation Delivery is responsible for seeking grant funds; the oversight and implementation of various statewide public transit grants; and coordinates human service transportation such as non-emergency medical transportation. Transportation grants offer general public transit services and assist in the mobility for the elderly, low income, and persons with disabilities.

c. KYTC District 4

The District 4 office in Elizabethtown will provide project status, updated construction project cost estimates and all other relevant data and information needed for the planning process to the Radcliff/Elizabethtown MPO.

IV. THE RADCLIFF/ELIZABETHTOWN METROPOLITAN TRANSPORTATION PLANNING PROCESS

A. Consideration of MAP-21 National Goals, The Eight Planning Factors and Livability Principles

In July, 2012 new federal transportation funding legislation was adopted. This legislation, titled Moving Ahead for Progress in the 21st Century (MAP-21), was based upon seven National Goals which will become the foundation for new performance-based planning requirements. These National Goals are summarized below.

NATIONAL GOALS — It is in the interest of the United States to focus the Federal-aid highway program on the following national goals:

<u>Safety</u> — To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.

<u>Infrastructure Condition</u> — To maintain the highway infrastructure asset system in a state of good repair.

<u>Congestion Reduction</u> — To achieve a significant reduction in congestion on the National Highway System.

<u>System Reliability</u> — To improve the efficiency of the surface transportation system.

<u>Freight Movement and Economic Vitality</u> — To improve the national freight network … and support regional economic development.

<u>Environmental Sustainability</u> — To enhance the performance of the transportation system while protecting and enhancing the natural

environment.

Reduced Project Delivery Delays — To reduce project costs … delays … and improve agencies' work practices.

As part of the metropolitan transportation planning process, the Radcliff/Elizabethtown MPO shall consider, analyze as appropriate, and reflect in the planning process, the eight (8) factors cited in the Moving Ahead for Progress in the 21st Century (MAP-21). They are as follows:

1. Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency;
2. Increase the safety of the transportation system for motorized and non-motorized users;
3. Increase the security of the transportation system for motorized and non-motorized users
4. Increase the accessibility and mobility options available to the people and for freight;
5. Protect and enhance the environment, promote energy conservation, and improve quality of life;
6. Enhance the integration and connectivity of the transportation system, across and between modes, for the people and freight;
7. Promote efficient system management and operation; and
8. Emphasize the preservation of the existing transportation system.

In addition, the UPWP recognizes the following Livability Principles as adopted by the U. S. Department of Transportation, the U. S. Department of Housing and Urban Development, and the U. S. Environmental Protection Agency."

1. Provide more transportation choices.
2. Promote equitable, affordable housing.
3. Enhance economic competitiveness.
4. Support existing communities.
5. Coordinate and leverage federal policies and investment.

B. The Unified Planning Work Program (UPWP)

Transportation Planning and related planning activities anticipated within the MPO area during the next one (1) year period, regardless of funding sources, shall be conducted as described in the Unified Planning Work Program (UPWP). The UPWP is to be prepared by the MPO in consultation with the KYTC and units of local governments. The UPWP is to be reviewed by the Technical Advisory Committee (TAC) and endorsed by the Transportation Policy Committee. The UPWP shall be acceptable to the FHWA and FTA. Substantial changes in transportation planning and

Appendix 21

2010

The Law of Sustainable Development: Keeping Pace

John R. Nolon
Pace University School of Law, jnolon@law.pace.edu

The Law of Sustainable Development: Keeping Pace

John R. Nolon*

Abstract: This article describes the emerging field of sustainable development law and examines whether it is up to the challenge it faces. In a world of finite resources overrun by sprawl, threatened by climate change, short on fuel, and long on greenhouse gas emissions, the law must keep pace. After discussing what sustainable development law is, the article considers the relationship between change in society and the evolution of legal principles, strategies, and practices, particularly with respect to land use, property, and natural resources. Documented in this review is the steady change exhibited in the common law applicable to the ownership, use, and preservation of natural resources, the rapid spread of zoning in the early 20th century, and the current explosion of climate change litigation and regulation. Based on these and other examples, the first half of the article demonstrates that the law can and does evolve in response to crises in society, particularly when lawyers, judges, professionals, and policy makers are trained to understand that law is an instrument for positive change. The article then turns to why law schools matter by drawing lessons from the author's personal

* This article is written in preparation for a lecture given in conjunction with my appointment as James A. Hopkins Professor at Pace University School of Law, where I also serve as Counsel to the Land Use Law Center and Director of the Kheel Center on Environmental Dispute Resolution. My thanks to Pace for this appointment and for the multi-year support it has provided for my scholarship on the topics covered by this article. Thanks also to several students who assisted with parts of this paper: Kelly Belnick, Alexandra Campbell-Ferrari, Noelle Diaz, Mike Goonan, Anne Ronan, Jamie Schenk-Allyn, and the editors of the Pace Law Review who did some heavy lifting of their own to document my narrative. My colleagues at the Land Use Law Center and Kheel Center whose steadfast commitment to using the results of our research to effect positive change on the ground have inspired my work more than they know. Heartfelt thanks to my stepfather, Watson W. Foster, for indelible life lessons too many to mention.

experience at Pace University School of Law.

Foreword: Too Big a Job

I grew up on a ranch in western Nebraska. My stepdad supervised us as we worked around the main house one day when a young man named Ernest came to work for the first time. I watched as my stepdad told Earnest to fill a wheel barrow with dirt from a pile near the house and move it to a spot near the corral. After each trip, my stepdad told Ernest to move another load, then another, then another. By mid-afternoon the entire pile of dirt was in its new location, where it was needed for a construction project. That night, I asked my stepdad why he didn't just tell Earnest to move the pile from the one place to the other. "Because," he replied, "that would have been too big a job."

As our society grows more populated, complex, and demanding, we expect our laws and lawyers to do heavy lifting as well. In my experience, particularly as a teacher and supervisor of student work, the movement of the law is a bit like this story about Ernest. Let me explain.

I. What is Sustainable Development Law?

In 1983, the Secretary-General of the United Nations tapped Gro Harlem Brundtland, Prime Minister of Norway, to chair the independent World Commission on the Environment and Development, which had just been created by the U.N. General Assembly. Following World War II, economic development tended to be unfriendly to environmental interests and, in many countries, leave the poor behind. It was the Brundtland Commission's task to address this problem.

In 1987, the Commission issued its report entitled *Our Common Future*. It defined sustainable development as development that meets "the needs and aspirations of the present without compromising the ability to meet those of the future."[1] The report begins with this aspiration:

1. WORLD COMM'N ON ENV'T & DEV., UNITED NATIONS, OUR COMMON FUTURE 40 (Oxford Univ. Press 1987) [hereinafter OUR COMMON FUTURE].

> This Commission believes that people can build a future that is more prosperous, more just, and more secure. Our report, *Our Common Future,* is not a prediction of ever increasing environmental decay, poverty, and hardship in an ever more polluted world among ever decreasing resources. We see instead the possibility for a new era of economic growth, one that must be based on policies that sustain and expand the environmental resource base."[2]

That economic development is linked to the quality of the environment is undeniable. The Commission noted that "[t]here has been a growing realization in national governments and multilateral institutions that it is impossible to separate economic development issues from environmental issues; many forms of development erode the environmental resources upon which they must be based, and environmental degradation can undermine economic development."[3] Those who urge environmental preservation are called upon to support sustainable development. Advocates of economic growth are urged to promote sound environmental protection policies.

The Commission, nearly a quarter of a century ago, gave us a clear signal: support policies that encourage the proper type of economic development in appropriate locations, in order to protect the environment and ensure that development benefits all economic classes. Economic development is to be modulated both to lessen poverty and to improve the environment, and to do this with a view toward the needs of future generations! Sustainable development comprises economic development, ecology, and intergenerational equity: a heavy load indeed.

The Brundtland Commission Report demonstrates that the serious threat of "global warming" was well understood over twenty-five years ago. Its words, and the evidence on which they are based, are not ambiguous. The report cites work done

2. *Id.* at 1.
3. *Id.* at 3.